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Railways, City Transit, Highways, Bridges, Tunnels and Canals, Water-Works, Artesian Wells, Irrigation, Sewerage and Municipal, Electrical, Contracting, Proposals Open, Manufacturing and Technical.

BORINGS FOR ROCK ALONG BROADWAY, in this city, are now being made for the use of the Rapid Transit Commission. As far as these borings go, they show the depth of soil from street surface to rock to be as follows: On Whitehall St. at Front, 20 ft.; Pearl, 16 ft.; Water, 23 ft.; Bridge, 20 ft.; Stone, 21 ft.; Beaver, 34 ft. On Broadway at Morris St., 35 ft.; Exchange Place, 61½ ft.; Wall, 60 ft.; Rector, 63 ft.; Pine, 70 ft.; Cedar, 70¾ ft.; Dey, 76 ft. 10 ins.; Fulton, 83¼ ft.; Vesey, 81½ ft.; Barclay, 101 ft.; Park Place, 112½ ft., and Murray St., 113½ ft. So far the overlying soil is sand, with a slight intermingling of clay, and now and then some vegetable matter. The borings will be continued to Fourteenth St., where the rock comes near the surface and continues about that plane northward.

THE COLUMBIAN FAIR DIRECTORY, at its last monthly meeting, reported that $1,644,224.61 had been received from all sources, and $422,868.83 had been expended. Mr. F. V. SKIFF was elected chief of the department of mines and mining. Mr. MELVILLE E. STONE has resigned as chief of the department of foreign affairs, and in his letter of resignation strongly intimates that he cannot stand the strong pressure for places for friends exerted by members of the local board, without reference to special fitness for office.

THE BOYNTON BICYCLE RAILROAD CO. proposes to build a line 20 miles long across Long Island, between Great South Beach and Rocky Point Landing, east of Port Jefferson. The capital of $200,000 is said to be subscribed, and the chief directors are F. W. DUNTON, G. E. HAGERMAN, JOHN R. SMITH, H. H. WALKER and E. H. RATH.

A RAPID TRANSIT COMMISSION FOR BOSTON is being formed. The Mayor of Boston selects three of the six commissioners, and the following names have been sent in to the board of aldermen: JAMES B. RICHARDSON, JOHN E. FITZGERALD and HENRY C. HIGGINSON. The Governor of the State has appointed JOHN QUINCY ADAMS, CHESTER W. KINGSLEY and OSBORNE HOWES, Jr. Politically the commission is evenly divided.

THE 12-IN GUN, that is soon to be tested at Sandy Hook, is especially interesting to both army and navy officers, who each advocate their peculiar type of gun. As the army officers are not restricted in weight, their gun is naturally the heavier; but they also differ in other features, as is shown by this general comparison:

	Army.	Navy.
Weight	52 tons.	45.2 tons.
Total length	36.66 ft.	36.8 ft.
Length of bore	34.00 ft.	34.93 ft.
Length in caliber	34	35
Powder charge	440 lbs.	425 lbs.
Projectile weight	1,000 lbs.	850 lbs.
Initial velocity per second	1,910 ft.	2,100 ft.
Striking energy	26,000 ft. tons.	25 985 ft. tons.
Pressure in chamber per sq. in	16 5 tons.	15 tons.

A NEW THING IN RATCHET DRILLS has recently been brought out and was on exhibition at the Master Car Builders' Convention, consisting of a ratchet drill which works with motion in both directions. The mechanism is very simple, and the motion is positive with either automatic or hand feed, as desired. For boiler and track drills especially its use should result in a considerable saving of time.

THE GROSS EARNINGS OF 137 RAILWAYS, operating 87,220 miles of road, for the month of May, according to the *Financial Chronicle*, are $36,774,414, as compared with $36,655,029 for the corresponding month of 1890. This is the poorest showing of any month of the present year. Of the 137 roads included, 62, or a little less than one-half, show decreases. The comparison, however, is made with one of the best months of last year. The influences which have contributed to this result have been many. The most general are the lighter grain movement, the coal miners' strikes, the depression in the iron trade, the diminished ore shipments from the Northwest, and the general business depression.

THE FOURTH AVE. TUNNEL of the New York Central R. R. is to be ventilated experimentally. The Railroad Commissioners have recommended the construction of an artificial roof, with an opening along the crown to admit the top of the smoke-stacks of the engines. The smoke and cinders will thus be kept out of the lower part of the tunnel, collecting in the space above the artificial roof, and being drawn out by forced draft. The railway company will give the plan a trial between 56th and 67th Sts.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a combined derailment and trestle accident on the Chicago, Milwaukee & St. Paul Ry. near Coon Rapids, Ia., June 16. A tie had been placed across the rails on the trestle approach to the Coon River Bridge, the trestle being 40 ft. high and the bridge 50 ft. above the water. The train was derailed, the engine and mail car breaking through the bridge and going into the river, while the baggage and smoking-car, chair car and one Pullman car fell off the trestle, turning over in their descent. Two persons were killed, one fatally injured and about 50 more or less seriously injured. An express train on the Louisville & Nashville R. R. ran into some flat cars loaded with cinders which had been left on the track near Sebree, Ky., on June 13. The engine, baggage and mail car and two of the flat cars were wrecked. One man was killed and two were fatally injured.

BRIDGE AND TRESTLE ACCIDENTS are reported as follows: On June 11 a derailed engine wrecked a trestle of the Columbus & Western R. R. over the Tallapoosa river, near Alexander City, Ala. The engine and 11 cars went down, but nobody was injured. A trestle near Loon Lake, N. Y., on the Chateaugay R. R., was burned June 9, and the engine of a passenger train went through. Two men were injured. One span at the Pittsburg end of the Sixth St. bridge between Pittsburg and Allegheny, Pa., was burned June 16. A bridge on the Chicago, Burlington & Quincy R. R. across Plum Creek, near Corning, Ia., was washed out by a freshet June 16, and the engine of a freight train went into the creek. Nobody was hurt.

A CALAMITOUS RAILWAY BRIDGE ACCIDENT occurred near Basel, Switzerland, on June 14, and appears to have been the most serious railway accident that has happened in Europe for a long time. The bridge was an iron structure, said to have been recently built, and had just been strengthened after sustaining some damage by the rising of the river. One report states that it gave way under the excessive weight of the engines, while another report states that the engines were derailed on the bridge. The train was a double header excursion train, crowded with people, and both engines and three of the cars went down into the river, which was only 4 ft. deep. The cars were completely wrecked, and the mass of wreckage supported the end of the first of the two rear cars, which would otherwise have gone down also. The front engine had already crossed the bridge, and had reached the abutment when the bridge gave way, and the engine was pulled back by the falling train. According to press dispatches, the number of persons killed was between 70 and 80, while nearly a hundred were injured. Relief trains were sent out, and soldiers and firemen from Basel were called upon to aid in the rescue.

THE NEW HOUSATONIC DAM, to take the place of the one swept out in the floods of last January, was commenced this week. The length of the dam will be 680 ft., or 45 ft. more than the old dam. The height will be 22 ft. from the top of foundation, and in plan it will be slightly curved. The cost is estimated at $300,000.

INTERESTING ELECTRICAL EXPERIMENTS are being conducted at the McGill University, in Montreal, preparatory to connecting with the Greenwich Observatory, in England, and thus exactly determining the longitude of Montreal and other points. Connection was made by wire over the Canadian Pacific Ry. lines with the Commercial Cable station at Canso, Nova Scotia. The land and ocean cables were made to work together, and a duplex circuit was arranged between the university at Montreal and the cable station at Waterville, Ireland. A chronograph was attached at one end of the circuit and the signal was made to return to its starting point. Through this round circuit of 8,000 miles of wire 120 signals were sent, and the average time of transmission for the round circuit was 1.05 seconds. The whole number ranged between 1 and 1.10 seconds.

A NEW MISSISSIPPI RIVER DAM is being discussed by the directors of the Pillsbury-Washburn milling syndicate. The site would be about one-half mile below the present dam at Minneapolis. This dam has been recommended for some time by Mr. C. A. PILLSBURY. The company now owns 8 acres of land at this point, and the new dam would be 35 ft. high and furnish 35,000 HP. The estimated cost is over $1,000,000, and the syndicate has authorized the expenditure of a still larger sum in the general improvement of the property.

THE ENGINEERS' CLUB OF PHILADELPHIA was officially chartered last week, the charter being filed by order of the Court of Common Pleas without the usual legal formula.

THE CONTROL OF THE NEW CROTON AQUEDUCT is in dispute between the Aqueduct Commissioners and the Department of Public Works. The latter department claims that the work is so far advanced that it should be turned over to the city authorities. President J. C. DUANE, of the Commission, takes the position that the works are not yet sufficiently advanced to warrant the Aqueduct Commission in turning over the whole structure to the city. Chief Engineer FTELEY reports to the Construction Committee that there are 7 large gatehouses and about 60 large gates of expensive and elaborate construction, that must be kept in perfect order for the regulation of the flow in the new aqueduct. These gates are now in charge of trustworthy men appointed by the Commission. It would be absurd and most unfortunate to mix up control at this season of the year, by placing the gates under one department and the tunnel under another. But the city evidently wants the "places" of the gatekeepers, few though they be; and the Corporation Counsel is appealed to by the Commission for his opinion on the question.

STREET CAR POSTAL BOXES are suggested by Postmaster HARLOW, of St. Louis. All collections would be turned in to sub-stations and thence sent directly to the post-office stations nearest to these. These postal cars should run on a time schedule. The directors of the more important street railway companies believe the scheme is feasible and that the expense would be slight in proportion to the gain in a quicker service.

Notes on the Nicaragua Canal.

(*Continued from page 557.*)

As bearing upon the work in the western section, it should be said that the nearest port of entry to Brito, now open, is that of San Juan del Sur, about 15 miles to the south. This port is a somewhat shallow bay, protected on both sides by high rocky headlands, circling around and inclosing the roadstead. Vessels drawing 18 to 20 ft. anchor in this bay at some distance from the shore, but can not approach the one rough pier provided for boats of lighter draft. The ships of the Pacific Mail Steamship Co. touch here once a month and all freight is taken off to them in lighters.

The road between San Juan and Brito is an exceedingly rough trail at present, passable only on mule back. In fact, all the roads in this section, with a very few exceptions near Rivas, are trails only, made solely by clearing away the timber. All country traffic is carried on with the native *carreta*, which is worth describing. This is a two-wheeled cart, with a very massive frame firmly fastened to the axle, and a long tongue rigidly attached to the frame. The wheels and their hubs are hewn out of a tree trunk in one solid piece, the wood used being a heavy native variety. The axle passes through the wooden hub, with a bearing of about 15 ins., and a diameter of 6 ins., and as little or no grease is used upon them the creaking of these carts is something that must be heard to be appreciated. The wheel, which is about 4 ins. thick, has a tire made of 4 × ½ in. strap-iron spiked on in sections about 2½ ft. long. These carts are hauled by four oxen usually, and their load is a limited one and the rate of traveling is exceedingly slow. But they can be taken over roads that would be simply impracticable for more modern vehicles. We traveled over some of these roads ourselves, which, in rocky sections, presented series of abrupt steps 2 ft. or even more in height; and in the dirt roads the ruts were worn down so deep that the axles scraped the middle ridge. In the dry season these roads are thick in dust, and in the wet season the deep mud makes them practically impassable in some sections. For traveling, mules and horses are used, the first being generally preferred by the natives.

Much baggage and lighter freight is packed on the backs of mules, using for this purpose an *albarda*, or native pack-saddle. This *albarda* has a long and wide flat wooden tree, slightly rounded at the sides, but is almost level fore-and-aft and without a pommel. It is covered with raw-hide, and wide raw-hide skirts, as hard as sheet iron, hang down the sides. A rope bridle and a pair of stirrups, into which the native usually inserts the big toe only, complete the outfit, in all respects, excepting that a spur strapped to the bare heel of the Indian is necessary if anything faster than a deliberate walk is expected from the beast itself. A Nicaraguan mule will move under the persuasion of a club just so long as the club is being wielded, and no longer; and as mule-clubbing under a tropical sun is very hot work, we advise our readers contemplating the use of a mule-motor in these regions to go equipped with a sharp pair of spurs. But we will also predict that the simple recollection of a 40-mile ride on a Nicaraguan *albarda* will make the victim ever after squirm uneasily in his seat.

The one railway of Nicaragua, owned and operated by the government, is remote from the canal route, but could be used as a link in the approach to the lake ends of the canal. This railway extends from the port of Corinto, on the Pacific, 58 miles to Momotombo, on Lake Managua; from this point to the town of Managua, 30 miles, there is a good steamer line running in connection with all trains; and between Managua and Grenada, on Lake Nicaragua, a distance of 33 miles, there is another railway line. These railways are well built, and the total equipment is American. The gage is 3 ft. 6 ins. At Grenada there is a pier running into 30 ft. of water, and on this lake is one very good steamer built in Wilmington, Del., and now owned by the Nicaragua Canal Co. The steamers plying on the San Juan River are of the stern-wheel type, common on the Ohio and upper Mississippi rivers. The various rapids at present existing in this stream, at Machuco, Castillo, Toro, etc., make frequent transfers necessary, each steamer plying only between its own particular set of rapids. As a consequence, in ordinary stages of water, all freight sent up the San Juan to the interior requires much rehandling.

Other railway lines are projected in Nicaragua, and the Atlantic Railway of Nicaragua is under contract and slow construction. This railway will be 128 miles long, connecting San Ubaldo, on Lake Nicaragua, with Boca de Rama, at the head of navigation on the Blewfields River, and 65 miles above the town of Blewfields. This road is located with a maximum gradient of 2½%, and crosses the summit ridge in an 1800 ft. tunnel at an elevation of 610 ft. above the sea. The gage would be 3 ft. 6 ins. Another line is projected to connect the present railway to Grenada with Rivas, which lies close to the canal line on the Western Division. English and American capital is said to be interested in these roads; but like nearly everything else in this Spanish-American state they are moving forward toward completion with a slow and stately tread. The inauguration of active work upon the ship-canal would doubtless put life into some of these enterprises.

The source of labor supply is an interesting topic in connection with the work on the canal. For the Atlantic slope the Jamaica negro will probably be depended upon; and they are anxiously awaiting further calls upon their services in canal digging. These negroes are well adapted for work in the tropics, and seem to like it. The line of the canal is in a region no hotter than their own island, and it is generally healthier, according to all accounts. But as we have before mentioned, this class of labor will require the enforcement of strict discipline to protect the workmen from the effects of their inherent fondness for liquor and general dissipation and their antipathy toward spending money simply for proper food and shelter. The latter must be furnished by the canal company, or the contractor, and accounted for in the pay allowed them.

In speaking of the labor required on the Atlantic slope it should be remembered that from Greytown to Lock No. 1, a distance of nearly 10 miles, the canal work is dredging only, a class of work performed by the powerful machinery now on hand, and requiring but little manual labor. This section of dredged canal at once removes the mass of the

CANAL CLEARING, LOOKING WESTWARD ACROSS LAGUNA BENARD, AND TOWARD THE RANGE OF HILLS FORMING THE ATLANTIC DIVIDE.

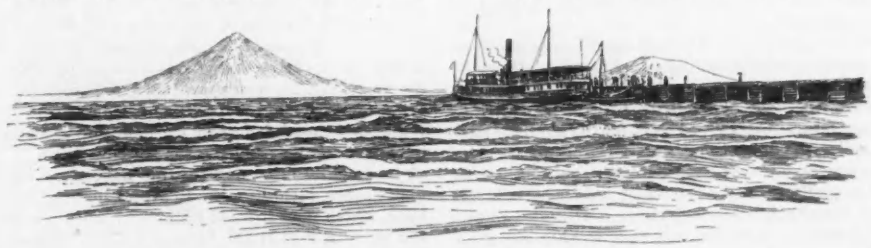
laboring force out of the Atlantic swamp region and on to the high Divide, where pure air, cool breezes and excellent water unite to make the conditions very favorable for health. The railway through this swamp is already built and in operation. Between the Divide and the Ochoa dam, a distance of about 12 miles, the work would be chiefly confined to railway and dam building; and as these follow the dividing ridge, between the canal and the San Juan River, the laborers could either return to the main camp on the Divide or camp on some of the higher hills adjoining the flow line.

For the Western Division native labor could be obtained with little effort from Nicaragua, Salvador and Costa Rica. And as it is advisable to separate the natives from the negroes in nearly all work, this source of labor is fortunate. Inquiry made among American and English employers in Nicaragua resulted in the statement that for $20 to $25 per month and subsistence at least 3,000 workmen of the best character could be obtained from the west coast of Nicaragua alone. These men would come from the class of small farmers who were once engaged in the now almost dead industry of cutting fustic. The same rate of pay and transportation advanced would bring about an equal number from Salvador and Honduras. The nature of the work between Lake Nicaragua and the Pacific is such that the greatest number of laborers will be required on this division. But the climate there

is unexcelled in Central America; food is plentiful and cheap, as much of the country is under cultivation, and supplies can be brought to the line either by the San Juan river and Lake Nicaragua, the Nicaragua railways and Lake Nicaragua or in the dry season by the much shorter route from San Juan del Sur, on the Pacific side.

The present price paid for ordinary native labor about Rivas, the chief town on the Western Division, is from 40 to 60 cts. per day and food, or 80 cts. per day without food. This rate is in Nicaraguan silver, which is at 30% discount as compared with gold. Those who have used them in contract work in this country speak well of the native laborers, and recommend them as sturdy, patient, easily taught rough work, honest and sober as a rule. They never strike, and under fair treatment their strong national pride leads them to do their best, because they think it will be appreciated. This is rather a roseate certificate for the common laborer and it may be overdrawn; but from our own observations we can certify to the sturdiness, the patience, the politeness and pride of the common Indian, qualities which certainly are promising.

As the canal company is now furnishing subsistence for the 600 men and officers employed about the Atlantic end of the work, inquiry made showed that the average cost per man was 62 cts. Nicaraguan money. On a gold basis this is about 44 cts. per man per day; and as the proportion of the officers now employed about the headquarters is great, as compared with the laboring force which these same officers could handle, the average cost would doubtless be much lower with a full force at work. The average ration in the United States Navy costs 30 cts. per day (gold); but this does not include transportation, storage, and a number of smaller incidental items that the canal contractor would have to meet in supplying food in this country.



LAKE NICARAGUA AND THE LANDING PIER AT SAN JORGE.

This s near the mouth of the canal at the west shore of the lake; the volcano of Ometepe and the island of Madera appear in the background.

Of skilled labor we should imagine there was little in this section, and that little of not a very good quality, judging from their work. The blacksmithing done on the native *carretas*, or carts, is of the rudest description, performed with the most primitive tools. All woodwork is made from timber sawn by hand, as there is not a saw-mill in the country to our knowledge. The native carpenter is very handy with an adze, and if you give him time enough and watch him closely enough he can do a fairly-good job at interior work for a house. But these men seem to belong to a different class from the common Indian that would have to be depended upon for ordinary labor, and the everlasting *manana*, or "to-morrow," is the plague of their employers.

(To be continued.)

The Ainley-Oakes Square-Hole Drilling Machine.

(WITH INSET.)

In our issue of Mar. 21, 1891, we copied from a foreign journal some illustrations of this ingenious machine for boring holes of square and other sections, and accompanied the illustrations with such description as was then attainable. But in the present issue we show the machine as reproduced from the working drawings, including the latest improvements and modifications. For this privilege we are indebted to the courtesy of Mr. A. D. JOHNSTONE, C. E., who, together with Mr. H. C. DRINKWATER, C. E., of London, is introducing the machine into the United States, and is actually having it manufactured at the works of the Pratt & Whitney Co., at Hartford, Conn.

The drawings will explain themselves to the mechanical engineer, but for the benefit of others the following general description will be sufficient: The frame and head of the machine are made of cast iron, and the spindle carrying the cutter is made of soft wrought iron, case-hardened on all working surfaces. The gearing is of cast iron or cast steel, with machine-cut teeth.

On the general sectional elevation it will be seen that the head, carrying the tool-holder, is arranged on slides and counterbalanced by weights in the interior of the frame which slightly exceed the weight of the sliding head and its attached gear. The tool-holder is driven from the pulley shaft by a beveled gear which operates a 5-in. pinion meshing into a 10-in. spur wheel near the head of the holder. The detail of this connection is shown enlarged on the "detail section *A B*," where the strong spiral springs connected with the spur-wheel by lugs admit of the necessary eccentricity of motion resulting from the fixed ball-and-socket joint on the spindle below, and a small guide wheel acting in a template near the top of the spindle.

For any definite form of hole one template alone is necessary; the different sizes of this particular form are obtained by raising or lowering the drill by the adjusting gear shown at the top of the sliding head, the adjusting screw being connected with the top of the tool-holder by a universal joint. The feeding gear is shown on "section *C D*" and on the general sectional elevation, within the rough outline inclosing this part.

The template is made of wrought steel, 12 ins. in outside diameter and ½ in. thick. It is held in place by two flat-sided bolts and nuts as shown. The detail of the inner guiding surfaces for templates is shown, for producing a square, hexagonal or oblong hole, or a circle with segment removed. This inner surface of the template is accurately faced. The guide-roller which travels on this face and thus controls the movement of the cutter, is 6¼ ins. in diameter and rests on a collar formed on the upper end of the tool holder. The two pairs of holes shown in these templates are there for the purpose of enabling them to be lifted from their seat by claw-spanners.

The cutting tool itself is of peculiar form, as shown in detail. The cutting edge is set at a slight angle with the horizontal, in one direction, and at a sharp angle in the other, the purpose being to permit a sharp, square corner to be cut out with it.

Though this description is made up from the drawings alone and not from the actual machine, work done by the machine has been seen. The particular specimen was a bar of cast brass, with holes completely and others only partly bored through. These holes were circular, hexagonal, a circle with a segment cut off, square, oblong and star-shaped. In the square hole, as in all the others having corners, these corners were cut out square and clean, practically without a fillet. The diameter or size of any special form can be adjusted with the limits of, say, 1 in. to 2¼ ins. on one machine and with the same template, by using the adjusting gear referred to. But for a wide range in size, machines of various sizes would have to be specially designed and constructed. This machine will also drill holes of any form in cast steel, and specimens of work of this kind were also brought to this country. The rate of cutting will depend, of course, upon the material being operated upon, but it is very rapid in brass.

The machine is not an expensive one to construct, and for those who have use for them a series of machines cutting holes of all useful sizes could well be afforded. There is said to be no limit, practically, to the form of hole desired, a special template being alone required. We do not know that owners of this machine have as yet any headquarters in the United States. But, meanwhile, anyone interested can receive fuller information by writing either to Mr. H. C. DRINKWATER or to Mr. A. D. JOHNSTONE, Engineers, 2 Prince's St., Westminster, London, Eng.

Contraction of Area of Cross-Section as an Index of Quality in Tests of Iron and Steel.

In ENGINEERING NEWS of March 7 was published the standard code of tests for materials, proposed for adoption by a committee of the American Society of Mechanical Engineers. In the same number some criticism was made of this code in that no allowance was made for reduction of area in tensile tests. Mr. PAUL KREUZPOINTNER, of Altoona, Pa., contributes the following defense of the position taken by the committee, which is of much interest, as it is contrary to general practice among engineers. While admitting that reduction of area is a point worthy of observation in special cases, he holds that in ordinary tests of iron and steel it is a misleading index of the value of the material. His argument is as follows:

The engineer who buys a certain metal suitable for his purpose would often be surprised to see the behavior of that metal when strained under other conditions than those which obtain when it is subjected to the specified tests. According to prevailing methods of testing, the quality of a metal is judged by certain well known phenomena observable at the point of rupture of the metal under test.

It is a simple method, to be sure, but it gives only an empirical determination of the tensile strength and elongation; and reduction or contraction of area is entirely misleading as an index of the quality of the material.

This method (measuring the reduction of area to determine the quality of a certain class of metals) ignores the multitudinous conditions to which the same class of metal may be subjected. It puts the question of adaptability into the strait-jacket of an inflexible formula, and virtually says to the engineer, "Because this method is good for one purpose, according to this formula, you must consider it especially good for every other purpose." Tensile strength and elongation are generally considered by the engineer in their proper relation to one another and to the uses to which a metal is to be put. Not so with contraction of area as a measure of the quality, "The more the merrier" is the standard adopted, irrespective of wear and tear of the metal in service, and irrespective of the important relations of the structure of the metal to its behavior at those stages of its service which determine its real value and safety.

Assertions without proof in matters pertaining to engineering are not worth the paper they are written on. This would apply as well to the assertion that reduction of area as a measure of quality is misleading if we did not have the proof of ocular observation, mechanical measurement and practical "hard cash" experience that the structure of that metal which gives the greatest contraction of area at the point of rupture, though its tensile strength may be as high as that of the metal with less contraction, is not so well adapted to resist abrasion, and does not possess that resilience and springy nature which is so essential to resist successfully the shocks and strains which tend to weaken and destroy a structure.

Where ductility is the main quality sought after, reduction of area may properly be considered, although even then, elongation is a much more reliable guide and is free from the errors which are unavoidable in measuring the reduction of area. But where elasticity, resilience, "body" and ability to endure wear and tear is wanted in a metal, there the reduction of area as a measure of its excellence becomes a delusion and a snare.

The deception arises from that peculiar and important, but little valued property of all metals, of flowing, under given conditions. The ductility of a metal, expressed in a given formula, is simply a numerical expression of the ability of that metal to flow. The easier a metal flows, the softer it is; the softer a metal is, the more ductile or pliable it is. Now, the percentage of contraction of area of

a metal is accepted as the gage of its ductility. Since this gage is set high by the engineer, which implies a high degree of ductility, and since ductility is the convenient term for the phenomenal of flow in a metal, we know that a high percentage of contraction of area means an easy flowing metal.

So far, so good. At this stage of our inquiry, however, we strike a snag in the fact that easy-flowing—that is, soft—metals, do not possess a high limit of elasticity; which property, after all, is the engineer's real, true, and only reliable friend and standby.

"But," some will exclaim, "how about the tensile strength? Is not the tensile strength an exponent of the desired stiffness of the metal we use, and if we have that and a maximum of contraction, viz., ductility, then have we not the ideal metal?" That sounds all very nice—on paper.

Let us examine two pieces of metal of different grades, under stress in a testing machine, the condition of the test being the same in every respect. Both pieces are of the same class of metal, say, axle steel, made by two different makers or by the same maker at different times.

As the effects of stress become visible we notice a very slight movement. Let us measure that movement at every 500 lbs. additional loading. At first the ratio of movement is alike in both metals. As the load increases, however, we notice in one metal that the amount of elongation (for each additional 500 lbs.) is greater than in the other metal. In other words, the amount of elongation is alike in both metals for each 500 lbs. for, say, 15 loadings. After this point is passed, the careful observer will perceive a want of uniformity in the extensions with each further loading. In one metal the extension will be the same to the 20th loading; a small increase takes place in the next loading, and so for several loadings there is a successive increase in elongation over the previous rate, yet the increase is in equal ratios like the numbers 1, 2, 3, etc. All at once we notice a perceptible increase, a jump, as it were, from 5 to 10. The next loading brings less extension, say only three points; the next only two, then for the next 3 or 4 loadings the extension is uniform again, when after this the extensions increase rapidly with every new load, but still with a delightful regularity until contraction begins at the point of rupture.

In the other metal we notice a very different behavior. The extensions cease to be uniform sooner than in the metal above described, the sudden "drop" is greater, and the further extensions are jerky; two or three regular, then a sudden large extension, then a few small ones, then a large one again, giving the impression of a gathering of strength, a rallying of forces to resist the enemy at another point, after having been forced from the position formerly occupied. In their efforts to resist, though unsuccessfully, the extraneous force from pulling them apart, the two metals may be compared to a trained disciplined body of soldiers and a body of untrained recruits.

Besides the points already mentioned, marked differences are exhibited in the surfaces of the two test pieces after fracture. The test piece from the metal which shows a uniform extension gradually tapers to the point of rupture, and the contraction of area at that point is not excessive enough to excite comment.

In the other metal, the one which showed the "jerky" extensions, the sides and surface are "knotty;" in flowing, the metal became denser in spots, and consequently stronger for a moment. This stage is also marked by the smaller extensions following a larger one, mentioned above; at the point of maximum load a perceptible thickening of the metal takes place, due apparently to the metal collecting there into one hard spot. To the formation of this hard spot is due the fact that this soft metal shows the same ultimate tensile strength as the other.

The formation of this hard spot also prevents the metal accumulated there from taking part in any further work. As a consequence of this, the remaining portion of metal of smaller cross-section between the two hard spots has to perform all the remaining work; and it is therefore drawn out excessively, due to its easy flow, to the delight of the enthusiastic believer in contraction as an index of quality. But the excessive drawing out of the remaining portion of metal between the hard spots is not so much due to its quality as it is an incident, depending more or less on the rate of speed with which the metal is tested, and consequently the rate of flow of the metal and its ability to gather strength, to reorganize, as it were, its scattering forces for a new stand against the assaulting enemy.

Let us now go back again and examine the merits of these two metals when at the point of divergence from uniform extension, as described above. Imagine the first metal, which showed the steady extension in service, to be subjected to an impact of 500 lbs., followed immediately by another blow of 1,000 lbs. The metal having "body," as shown by its behavior under test, it will "catch" the weight suddenly thrown upon it; and though perhaps severely tried, it will not yield to the attack, but will hold its own.

Now try the same process with the metal of no "body" and "jerky" extension under load.

The sudden impact of the load will bring it on the brink of one of the large "jerks" mentioned; and not having body enough—that is, a suitable structure, a network of hard crystals running through the soft mass of the metal (as in No. 1), to "catch" the weight—down she goes over the brink, getting hurt by getting fatigued, and there is the beginning of a "fracture in detail," which, under the next repetition of a similar sudden load, is continued inward into the mass of the metal until, sooner or later, a break occurs.

Now, this is in brief, the nature, life, and death of two metals, which are of equal tensile strength, but different structures; the one suitable for its purpose, worth all the money paid for it, reliable and safe, but rejected as inferior by the theorist, who relies on contraction as an index of quality; the other possessing very good qualities, but subject to sudden spells of weakness, which weakness is liable at any time to develop into chronic disease and untimely death. Nevertheless, this weaker metal is gladly accepted by the engineer because, according to a prevailing theory, the last manifestation in the life of the metal, contraction of area, is considered a sign of superior quality, when in fact it is a sign of inherent weakness, not harmful in one case perhaps, but harmful in half a dozen others, the harm being often masked by the complexity of circumstances usually accompanying the use of structural metal.

Accepting contraction or reduction of area as a reliable measure of quality for a structural material which has to sustain sudden and variable stresses, often equal to its full working load, is like measuring the former strength of a gladiator by the convulsive, involuntary, muscular contortions when he is lying, mortally wounded, in the throes of death.

Notes on English Railways.

(*Continued from page 570.*)

The previous articles have all been devoted to English railways proper, but particulars will now be given of some of the Scotch and Irish lines. Scotland has about 3,000 miles of railway, a large proportion of which is single track. During the tourist and hunting seasons of the summer and autumn there is a very heavy traffic, for which there is sharp competition. Through trains and cars are run from London and other large cities of England to Edinburgh and Glasgow, and as far north as Aberdeen and Inverness. On the mountain divisions there is some very bold construction. The scenery is in many places wild and grand, but it would be seen to much better advantage from observation cars than from the ordinary English compartment cars and saloons.

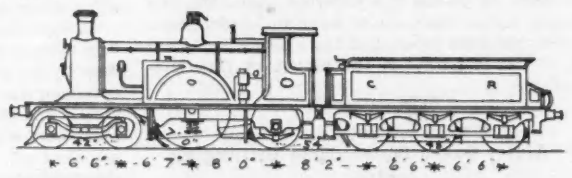


Fig. 71. Express Locomotive, Caledonian Ry., Scotland.

CALEDONIAN RAILWAY.

This is one of the most important of the Scotch lines, and has a total length of about 800 miles. It has a line from Carlisle to Edinburgh (101 miles) and Glasgow, which forms the Scotch section of the West Coast and Midland through routes to the north. It has also lines up through the interior to Perth and Aberdeen. There is a very large traffic of local and main line trains at the Central Station (terminal), Glasgow. A little way beyond the train shed is the main signal box, and in front of it are low wooden platforms between some of the tracks. Here a man is stationed to expedite the working of the trains. He observes the movements of the semaphores, and by whistle and hand signals directs the engine drivers to pull out, back up, run into a side track, etc.

Track.—This is of the ordinary type, consisting of bull-head rails in chairs which are secured to the ties by one or two spikes on each side of the rail, or by one spike and one trenail on each side. A considerable length of track was noted in which two of the four holes were left empty, only one fastening having been put in on each side. The wooden keys are on the outer side of the rail. The rails are laid with square suspended joints, spliced by plain splice bars and four bolts, with the nuts generally on the inner side, but sometimes on the outer side of the rail. The ballast is of broken stone or slag, level with the tops of the ties. There are 13 ties to a rail length.

Locomotives.—This road has about 700 locomotives. Engines with a single pair of driving wheels have been used in passenger service for a number of years. In 1856 it had some six-wheel engines with a single pair of 7-ft. driving wheels, and in 1861 it had similar engines with outside cylinders 17½ × 24 ins., driving wheels 8 ft. 2 ins. diameter, leading and trailing wheels 3 ft. 8 ins. diameter, a wheel base of 15 ft. 8 ins. and weighing 68,656 lbs. Outside cylinders and leading trucks are features of a number of the engines of modern construction. The most notable engines are those with a single pair of driving wheels and leading truck, as shown in Fig. 71, which are used for express passenger service and one of which has done some very remarkable work between Carlisle and Edinburgh in connection with the "race to the north." The distance is 101 miles and the line has some unfavorable grades, including the Beattock incline, 10 miles long, which rises toward Edinburgh with grades of 1 in 88, 80 and 75 (1.136, 1.25 and 1.33%). Engine No. 123, of the class illustrated, is especially celebrated for work on this run, and has made the 101 miles in 104 minutes, with tender weighing 33½ gross tons and a train load of 75 to 80 tons. The dimensions of this engine are given in the accompanying table. The cylinders are inside the frames, with the slide valves between them, and the engine is fitted with the Joy valve gear and an air jet sanding apparatus. The truck is of the swing link type. The tender is carried on 6 wheels 4 ft. diameter on rigid axles, with a wheel base of 13 ft. It weighs 75,040 lbs. loaded. There are a number of engines of the eight-wheel type, with inside cylinders 19 × 26 ins., driving wheels 6 ft. 6 ins. diameter, and weighing 100,800 lbs., with 68,096 lbs. on the driving wheels. With the large inside cylinders the space for the slide valves is very limited and it is difficult work to face the seats. In some cases the slide valves are placed on top of the cylinders. The big ends of the connecting rods of some inside cylinder engines have the caps secured by 2 bolts parallel with the rod, similar to the practice in marine engine work. On some of the outside cylinder engines with 4 coupled wheels and a single pair of leading wheels, the latter have outside bearings and laminated springs hung below the axle boxes. Steel fireboxes have been tried, but it is said they were not found to work as well as the copper, while the latter can be patched and repaired. Boilers have been built for 200 lbs. pressure, but this was found to be excessive, being too hard on the valves, etc., and the general working pressure is 175 lbs. The hand brakes on the tenders are operated by a vertical wheel and bevel gearing instead of the usual cross bar handle on the top of the vertical shaft. In the yards at Glasgow was noticed a small four-wheel tank switch engine, with a dwarf crane o 3,360 lbs. capacity mounted on the smokebox. The Westinghouse brake is used, as on all the Scotch

lines. Passenger engines are painted a dark blue, with black and white striping, and the frames are a dark chocolate or plum color. Mineral engines are painted black, with red and white striping and red coupling and connecting rods. Passenger engines are said to frequently take trains through between Carlisle and Aberdeen, 240 miles.

Locomotive Works.—The company has extensive locomotive and car works at St. Rollox, a manufacturing district of Glasgow. These works were reorganized in 1883, and are well arranged and equipped. They turn out about 20 new locomotives per annum. The large light building for paint shop and

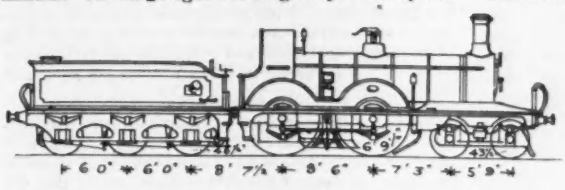


Fig. 72. Eight-Wheel Locomotive; Glasgow & Southwestern Ry., Scotland.

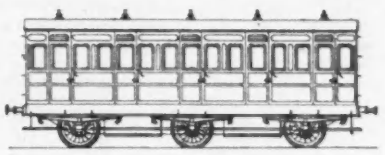


Fig. 73. Standard Passenger Car; Glasgow & Southwestern Ry., Scotland.

cushion shop is located at a distance from the dust and dirt of the other shops. In the foundry, machine molding is employed for axle boxes. Jets of compressed air, supplied by a Westinghouse engine, are used for clearing away the loose surplus sand, each molder having a flexible pipe which he moves rapidly around the mold. Passenger cars are also built at these works. At the time of the writer's visit the works were under the charge of the late Mr. HUGH SMELLIE, Locomotive Superintendent of the road.

Rolling Stock.—A number of the modern cars and saloons are carried upon four-wheel trucks. Some of the first-class cars of this kind have coupé ends and lavatory arrangements similar to those of the Midland Ry. car illustrated in Fig. 53, p. 439. They are 48 ft. 6 ins. long over the buffers, 8 ft. wide outside and 7 ft. 6 ins. inside, 6 ft. 1¼ ins. high inside at the sides and 7 ft. 2 ins. at the middle. The seats have horse-hair cushions and backs with coiled springs, and the sides and doors are padded. The upholstering is generally of carpet cloth. The interior is finished in sycamore and maple, with gilt moldings. The Macnee dust-proof axle box is used (ENGINEERING NEWS, May 2, 1891), and also Macnee's electric system of communication between the passengers, conductor and engine-driver. The Pintsch gas-lighting system is used, and Anderson's ventilators are fitted to the lavatories and smoking compartments. The third-class cars have 8 compartments (80 passengers). The seats and sometimes the backs are cushioned, while some have the wooden back of the seat shaped to fit the human back. The interior is painted and grained a light yellow and the floor is bare. The trucks have steel frames, 45-in. Mansell wheels with teak centers, and a wheel base of 8 ft. Mahogany is used for the exterior paneling of the cars. Local trains have the cars close coupled, with a middle buffer and coupling and 2 safety chains. A prison car was noticed in the shops. The trains are fitted with the Westinghouse brake, and through cars running over the London & Northwestern Ry. are fitted with the vacuum automatic brake used on that line. Steam heating has been tried on some of the Glasgow suburban trains, the steam being taken from the engine and conveyed through a pipe under each seat. The cars are printed a very dark plum color. At the Central Station, Glasgow, a wheel tapper was noticed who found a wheel that did not ring true to the hammer. After making an examination he took from his pocket a printed repair card, white, with broad blue diagonal stripes to make it conspicuous, and after writing "loose tire" in the blank space for "Nature of Repair," he nailed it onto the footboard. This card required the car to be sent to the repair shops.

GLASGOW & SOUTHWESTERN RAILWAY.

This is an important Scotch railway, with an aggregate length of 350 miles. Its main line extends from the border near Carlisle to Glasgow, and over it are run the Midland Ry. through trains between London and Glasgow. The large terminal station at Glasgow, the St. Enoch station, has 9 tracks, arranged in 3 sets of 3 tracks each, with 2 wide platforms and a narrower platform along each side wall of the station. As at many other large terminal stations, a handsome hotel building is erected in front of the train shed, making an imposing appearance. There is a very heavy local traffic between Glasgow and Greenock, at the mouth of the Clyde.

Track.—The track consists of bull-head rails in chairs which are secured to the ties by 2 spikes on the outer side and 1 spike on the inner side of the rails. The rails are laid with square suspended joints, spliced by plain splice bars with 4 bolts, having the nuts on the inner side of the rail. The wooden keys are on the outer side. Some supported joints were noticed, the rail ends being carried in a cast-iron chair, with a jaw on the outer side, and secured by one spike on each side. Plain splice bars were used, and the arrangement was in general similar to that of the joint on the Metropolitan Ry., shown in Fig. 45, p. 421.

Locomotives.—As on most of the Scotch lines, the equipment includes some powerful passenger engines of the "eight-wheel" type. One of these engines is shown in Fig. 72, and the leading dimensions are given in the accompanying table. The cylinders are inside the frames, and are slightly inclined. Each truck axle has laminated springs over the boxes, and these springs are connected by equalizing levers. Side bearings are fitted on the outside of the truck frames. Height from rail to top of smokestack, 13 ft. There is no dome, steam being taken from a pipe along the inside of the top of the boiler. Westinghouse driving-wheel brakes are used, and are arranged sometimes as spread and sometimes as squeeze brakes. Some of the eight-wheel engines have had driving wheels 6 ft. 1½ ins. and 7 ft. diameter. There are also large engines with 4 coupled wheels and a single leading axle. The cabs are of iron, bent to form an arched roof. There are a number of tank engines of the Forney type, with the iron cab extending back to the bunker, and having only openings at the sides over the steps. The engines are painted a very dark, blackish green, with black and cream striping. The smokebox and smokestack are black. Mr. J. MANSON is Locomotive Superintendent.

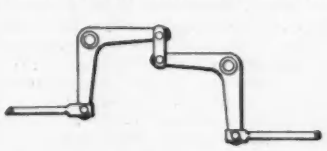


Fig. 74. Switch Rod Compensator; Great North of Scotland Ry.

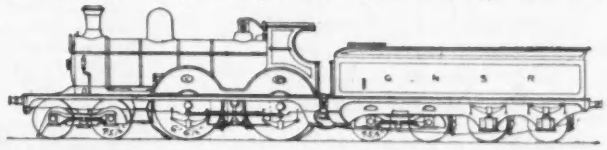


Fig. 75. Eight-Wheel Locomotive; Great North of Scotland Ry.

Rolling Stock.—This road, like the Midland Ry., has only two classes of accommodation. The standard passenger cars, shown in Fig. 73, are carried on 6 Mansell wheels 3 ft. 7½ ins. diameter, on rigid axles. The body is 31 ft. long, 8 ft. wide, 7 ft. 3⅝ ins. high inside. The wheel base is 21 ft.; height from rail to top of roof, 11 ft. 9¼ ins. Weight, 29,120 lbs. The third-class cars of this type have generally 5 compartments, seating 10 passengers in each compartment, but some of them have 6 compartments (60 passengers). As a rule there are separate cars for each class. Hot-water heating is said to have been tried, a small boiler being placed over the roof lamp of each compartment, and connected with circulating pipes under the seats. The cars are painted a dark crimson, not unlike the color of the Midland Ry. cars, but of a duller shade.

GREAT NORTH OF SCOTLAND RAILWAY.

This system has a length of 316 miles. Its main line is from Aberdeen to Banff and Elgin, forming one link of the through route to the extreme north, and the other part of the system is made up of a number of branches. It has a line from Aberdeen west to Ballater, as near to Balmoral (where is located the queen's favorite residence, Balmoral Castle) as the queen will permit it to come.

Track.—The Deeside Ry., which is the name of the line to Ballater, is laid with double headed rails in chairs secured to the ties by 2 spikes on the inner and 1 spike on the outer side of the rail, or in some cases by 1 spike on each side. The rail joints are square and suspended, spliced by plain splice bars and 4 button-head bolts, with the nuts on the outer side of the rail. The wooden keys are also on the outer side. Each key is secured by a vertical iron key which fits into a vertical groove in the jaw of the chair and bites into the wood, thus preventing the key from slacking back. Some plan of this kind is very necessary, as the writer has seen on the best English lines keys which have worked nearly or quite out of the chairs. On some roads a nail is driven vertically between the key and the jaw of the chair, while on others a nail is driven into the key on each side of the jaw of the chair; but such methods are not effective and spoil the neat appearance of the track. The ballast has a boxing of fine gravel covering the ties, and covering the outer side of the chairs, but kept clear of the joints. The rail joints on some side tracks are supported, the rail ends being carried in a chair similar to, but a little wider than, the ordinary chairs, which is fastened to the tie by a spike on each side. The rails are secured by a horizontal wooden key on the outer side, no bolts being used. The switch rod compensators consist of two bell-cranks connected by a link as shown in Fig. 74.

Locomotives.—The finest locomotives on this road are powerful and handsome engines of the eight-wheel type, a type which is very extensively used in Scotland for fast heavy passenger traffic. One of the largest of these engines is shown in Fig. 75, and its dimensions are given in the accompanying table. Similar engines, but with driving wheels 6 ft. 0½ in. diameter are also in use. The engines have balanced slide valves, placed on top of the cylinders, swing link trucks, steam jet sanding apparatus, Westinghouse driver and tender brakes, and the train tablet exchanging system invented by Mr. JAMES MANSON, formerly of this road, but now Locomotive Superintendent of the Glasgow & Southwestern Ry. Some of the engines have equalized truck springs. The ordinary type of tender, with six wheels, is generally used, but some of the engines have eight-wheel tenders, which have a four-wheel truck similar to the engine truck at the front end, and two rigid axles at the rear, as shown in Fig. 74. These tenders weigh 80,640 lbs. The engines are painted a rather dull shade of light green, with darker green outside the paneling, and with black, dark green and cream striping. The frames and splashers are Indian red. The smokebox and smokestack are black, and the tender has brass letters on the side of the tank.

Rolling Stock.—Most of the passenger cars are carried on 4 or 6 wheels, with rigid axles. The Westinghouse train brake is used, as on most of the Scotch railways. The shoes are of cast iron, and there are 2 shoes to each wheel of four-wheel cars, and to the 4 outer wheels of six-wheel cars. Canvas-clad hose is used, and there is a cock on the vertical leg of the brake-pipe at each end of the car. The cars are painted a reddish plum color.

HIGHLAND RAILWAY.

This system has a total length of 426 miles, and extends from Perth up through the interior to

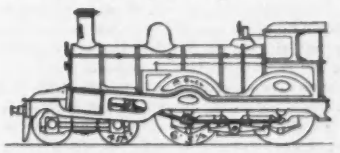


Fig. 76. Eight-Wheel Locomotive; Highland Ry., Scotland.

Inverness, and then mainly along the east coast to Wick and Thurso, at the extreme north and northeast points of Scotland, from which places it carries a large fish traffic. The line is mostly single track and has been very largely worked by telegraph and train orders on the American plan, but the new regulations of the Board of Trade will require the

adoption of the block system. The road has a number of outside cylinder engines of the eight-wheel type, one of which is shown in Fig. 76. This engine has cylinders 18x24 ins.; driving wheels, 6 ft. 3½ ins. diameter, truck wheels, 3 ft. 9½ ins.; and weighs 91,840 lbs. Some of these engines have connecting rods of round section. The equipment includes some long passenger cars on four-wheel trucks and also a number of snow plows. The engines and cars are painted a light olive green, and the former have Indian red frames. This road has an enormous traffic during the tourist season and through cars are run from nearly all the principal roads in England, except the southern roads. Mr. ACWORTH in his book on "The Railways of Scotland," mentions crowded trains of 20 and 22 cars in August, 1888, and also in the same month a train made up of 37 cars belonging to nine railways. This train was drawn by two engines and a third was put on behind to help it over the grades of the mountain division. The composition of this train was as follows: Sleeping car, 1; saloons, 3; first-class cars, 2; second-class, 1; third-class, 4; composite, 3; conductor's car, 1; baggage cars, 5; mail car, 1; meat car, 1; carriage cars, 2; horse boxes, 13; total, 37. Unfortunately no estimate is given of the weight.

DIMENSIONS OF LOCOMOTIVES.

	Fig. 71.	Fig. 72.	Fig. 75.
	Cal. Ry.	G. & S. W. Ry.	G. N. S. Ry.
Cylinders	18 × 26 ins.	18¼ × 26 ins.	18 × 26 ins.
Diam. truck whls.	3 ft. 6 ins.	3 ft. 7½ ins.	3 ft. 9½ ins.
Diam. driv. whls.	7 ft. 0 ins.	6 ft. 9½ ins.	6 ft. 6½ ins.
Diam. trail. whls	4 ft. 6 ins.	.....	.....
" boiler	4 ft. 3 ins.	4 ft. 3 ins.	4 ft. 4 ins.
Tubes, No.	196	238	.....
" diam	1⅝ ins.	1¾ ins.	.....
" length	10 ft. 7 ins.	10 ft. 11⅛ ins.	10 ft. 10⅛ ins.
Heat surf.: tubes	973 sq. ft.	1,092 sq. ft.	1 087 sq. ft.
" firebox	112 "	106 "	106 "
" total	1,085 "	1,198 "	1,193 "
Grate area	17.4 "	17.5 "	18 "
Wheel base: driv.	.....	8 ft. 6 ins.	8 ft. 9 ins.
" truck	6 ft. 6 ins.	5 ft. 9 ins.	5 ft. 6 ins.
" total	21 ft. 1 in.	21 ft. 6 ins.	21 ft. 6 ins.
W't on truck, lbs.	30,240	16,464 / 16,128	32,256
" driv. whls. "	38,080	33,600	32,480
" trail. whls. "	25,536	29,792	29,344
" total "	93,856	95,984	94,080
Tank, U. S. galls.	3,420	3,000	3,600
Coal, lbs.	11,200	11,200	13,440

E. E. R. T.

(To be concluded.)

Manganese Steel.*

Manganese steel is an alloy of iron and manganese, incidentally, and probably unavoidably, containing a considerable proportion of carbon.

The effect of small proportions of manganese on the hardness, strength and ductility of iron is probably slight. The point at which manganese begins to have a predominant effect is not known: it may be somewhere about 2.5%. As the proportion of manganese rises above 2.5% the strength and ductility diminish, while the hardness increases. This effect reaches a maximum with somewhere about 6% of manganese. When the proportion of this element rises beyond 6% the strength and ductility both increase, while the hardness diminishes slightly, the maximum of both strength and ductility being reached with about 11% of manganese. With this proportion the metal is still so hard that it is very difficult to cut it with steel tools. As the proportion of manganese rises above 15% the ductility falls off abruptly, the strength remaining nearly constant till the manganese passes 18%, when it in turn diminishes suddenly.

Steel containing from 4% to 6 5% of manganese, even if it have but 0.37% of carbon, is reported to be so extremely brittle that it can be powdered under a hand-hammer when cold; yet it is ductile when hot.

We have here another of the endless cases in which the properties of the alloy differ greatly from the mean of those of its components. This usually astonishes the novice, and even experienced metallurgists are often betrayed by it into expressions of surprise. It is, in fact, about as surprising as the parallel fact that the properties of water are not the mean of those of oxygen and hydrogen, and that those of peroxide of hydrogen are not directly deducible from those of water and oxygen.

Passing by such striking properties of manganese steel as its freedom from blow-holes; the great difficulty with which it welds; the increase in its toughness caused by quenching from a yellow heat; its electric resistance, enormous, and very constant with changing temperature; its low thermal conductivity—passing these by, one group of qualities stands out as that which must create and yet limit its value in the arts. I refer to its remarkable combination of great hardness, which cannot be materially lessened by annealing, and great tensile strength, with astonishing toughness and ductility; this group, I say, must at once create and limit its usefulness. The very fact that manganese steel cannot be softened, that it ever remains so hard that it can be machined only with great difficulty, at once sets up a great barrier to its usefulness; yet a barrier which, as we shall soon see, is not so insurmountable as it might at first appear.

On the other hand, if, as I believe, this cheap metal has a much higher combination of the important properties of hardness and ductility than exists in any other known substance, metallic or non-metallic, we can hardly hesitate to prophesy for it an important and useful future, for we can hardly doubt that for some important purposes this combination is extremely desirable. This combination is illustrated by these strips which have been bent double cold, and yet can barely be filed.

RESISTANCE TO ABRASION.

The results given in Table I. were obtained by Mr. T. T. MORRELL, Chief Chemist of the Cambria Iron Works, by pressing weighed pieces of manganese steel and of other steel, with a constant pressure, against a rapidly revolving hardened steel shaft, and as certaining the loss of weight which each piece underwent per thousand revolutions of this shaft. Here manganese steel indeed wears faster than tempered tool steel: but this is not a material which enters into competition with manganese steel, as it is not ductile. The difference between the wear of manganese steel and of that of the other steels tested is very great.

TABLE I.

ABRASION BY A REVOLVING HARDENED STEEL SHAFT.

Loss of weight of manganese steel	1.0
" " " " blue-tempered hard tool steel	0.4
" " " " annealed hard tool steel	7.5
" " " " hardened Otis boiler-plate steel	7.0
" " " " annealed " " "	14.0

The advantage of manganese steel is much less striking, as explained beyond, when it is exposed to abrasion by an intensely hard substance, like emery. This is shown in Table II.

TABLE II.

ABRASION BY AN EMERY WHEEL.

Loss of weight of hard manganese steel wheels	1.00
" " " " softer "	1.19
" " " " hardest carbon steel wheels	1.23
" " " " soft " "	2.85

HARDNESS AND RIGIDITY.

The hardness of manganese steel seems at first to be of a peculiar nature. We class together under the single term "hardness" what seem to be several tolerably distinct properties. These, though they habitually coexist, do not necessarily. Resistance to abrasion, to indentation by a sharp object, and to compression, habitually go hand in hand; yet, on reflection, we see that there is no *a priori* reason why they must coexist. I think that the tensile elastic limit should be closely related to the cohesion of the substance along the lines of least cohesion, or to the minimum cohesion. The resistance to abrasion, should the lines of low resistance be far apart, may bear little relation to this minimum cohesion, but be dependent on the cohesion between the particles immediately exposed to abrasion and those next them. The tensile elastic limit and the ultimate tensile strength of an emery wheel are very low, its resistance to abrasion enormous. That is because its minimum cohesion, which occurs between the grains of emery and their cementing matter, is very low; while the cohesion between the molecules of any one individual grain of emery is enormous. Among absolutely homogeneous substances, free from initial stress, the resistance to compression, to abrasion and to tensile distortion should be proportional. It is, I take it, because many substances are heterogeneous, with lines of low resistance, like the joints in brickwork, the cleavage in crystals, the grain in wood, that these properties often bear so little relation to each other.

Again, while the resistance to compression in a material which yields by bulging should be related to the tensile elastic limit, since such substances simply take set under compression, the particles changing their relative positions without solution of continuity, the resistance to abrasion should be related to the ultimate tensile strength, since each is measured by the force needed to break continuity by tearing particle from particle. This force at the plane where any two particles are torn apart is in either case a pull, *i. e.*, tensile.

The resistance to abrasion, moreover, should be related to the coefficient of friction of the metal; or, regarding the surface of the metal as like a brush or the surface of a file, the abrasion and the coefficient of friction should depend on the depth to which the teeth of the abrading file fit between those which it is to abrade, and the mode of distribution of the teeth of the two files which are abrading each other.

Be this as it may, the hardness of manganese steel seems to be of an anomalous kind. The alloy is hard, but under some conditions not rigid. It is very hard in its resistance to abrasion; it is not always hard in its resistance to impact. I do not recall a case in which it has not shown itself very hard when exposed merely to abrasion, yet there are cases in which it has not shown itself hard under repeated impact.

I do not refer to the mere fact that it can be indented by a sharp blow; this power of enduring distortion is almost a necessary consequence of its great ductility. I refer to its behavior under conditions like those of a hammer-head or stamp-shoe. As a material for stamp-shoes, for horse-shoes, for the knuckles of an automatic car-coupler, manganese steel has not met our expectations, When we remember how many of us have been studying carbon steel these long years, and how ignorant we must yet confess ourselves concerning even some of its prominent characteristics, there is little wonder if, in speaking of so little studied a material as manganese steel, I must admit that its rigidity in certain cases, its pliancy in others, is puzzling.

ARMOR PLATES.

The armor plates which I will soon describe give an instance of apparently great rigidity under shock; but it is probable that the reason why the manganese steel armor plates did not crack while the steel one did, is that the manganese steel can undergo such great distortion without failure of continuity. For, though the plates as a whole are but little distorted, the metal immediately about the holes must have been distorted greatly, yet but trifling cracks appear.

CAR AXLES.

Another instance of rigidity under shock is that of a manganese-steel car axle tested by HADFIELD, in comparison with a special carbon steel axle. Each was struck repeatedly by a 20.75-cwt. ram, while resting on supports 3 ft. apart, and each was reversed after every blow, in the usual way. The manganese steel axle received, up to the time of breaking, blows representing 43% more energy than those received by the carbon steel axle; yet the total deflection of the manganese steel axle was very much less than that of its competitor.

TABLE III.

TESTS OF MANGANESE AND OF CARBON STEEL AXLES.*—HADFIELD.

Effect produced by the number of blows as below.	Energy developed in foot tons.	SUM OF PERMANENT DEFLECTIONS OR BENDS IN INCHES PRODUCED ON—	
		No. 1. Special Steel Axle.	No. 2. Manganese Steel Axle.
At the fifth	79 883	24.953	8.501
" tenth	208.531	66.188	19.403
" fifteenth	348.591	105.248	30.212
" twentieth	497.988	And broken.	39.491 And broken.

CAR WHEELS.

A case of good behavior under shock is furnished by a 33-in. manganese-steel car wheel, weighing about 612 lbs. It was dropped edgewise on a one-ton steel block, bedded in the ground, repeatedly, from gradually increasing heights, with the results given in Table IV. For comparison an American chilled cast-iron wheel, made by one of our best makers, and also some excellent carbon steel wheels, were tested in the same way.

TABLE IV.

DROP TESTS ON MANGANESE STEEL AND OTHER CAR WHEELS.

MANGANESE STEEL WHEEL.		SOFT CARBON STEEL WHEEL.		CHILLED CAST-IRON WHEEL.	
No. of drops.	Height of fall.	No. of drops.	Height of fall.	No. of drops.	Height of fall.
	Ft.		Ft.		Ft.
2	16	1	10	1	4
2	28	1	11	1	6
	Rim slightly cracked	1	12	1	10
		1	13		Broke into six pieces.
3	28 Tread broken through	1	14 Cracked slightly.		
		7	15		
		1	18 Cracked about ¼ across the face of the tread.		
Total height dropped	368	.....	183	.....	20
Average height of drop	26.3	.....	14.1	.....	6.7

The total energy represented by the work done on the manganese steel wheel was 100 foot-tons, or 18 times as much as in case of the cast-iron, and twice as much as in case of the carbon steel: and this, although the average fall of the manganese-steel wheels was four times that of

*A paper by HENRY M. HOWE, Boston, Mass., read at the Providence Meeting of the American Society of Mechanical Engineers.

* Excerpt *Proc. Inst. Civ. Engineers*, XCIII., Part III., 1888, p. 29.

the chilled cast-iron and nearly double that of the carbon steel.

AXES.

Again, manganese steel axes have chopped cold iron bars through. Here we have great rigidity under shock.

Yet in other cases manganese steel has not shown the rigidity which those I have just described would lead us to expect. However, I know of none in which managanese steel has proved brittle under shock, except in early experimental work, in which the steel was unwisely given too much carbon, and further excepting untoughened manganese-steel castings.

A partial explanation of the cases I have referred to, and of others, and an inference from them, is that manganese steel is more rigid than the soft steels with which it competes in ductility, but less rigid than the hard steels which it excels in hardness.

To sum this up, in resistence to abrasion alone, manganese steel excels the hard carbon steels (when unhardened), and *a fortiori* the soft steels. Where both abrasion and repeated shocks are to be resisted, manganese steel is certainly less liable to break than the hard carbon steels; but whether, under new conditions combining shock and abrasion, it will prove as rigid as the carbon steels with which it will then have to compete, direct experiment alone can tell.

HARDNESS EVADED AND SURMOUNTED.

Having called your attention to the great obstacle to the use of manganese steel, its persistent hardness, let me now point out how this obstacle may be evaded and even surmounted.

Fortunately manganese steel forges readily at a yellow heat, though at a bright white heat it crumbles under the hammer. But it offers greater resistance to deformation, *i. e.*, it is harder when hot, than carbon steel. This increases the cost of forging to a certain extent, and, if very great reduction of cross section is to be affected by forging, the increased cost may be very serious; hence, it is desirable that the ingot or other casting which is to be forged should have, when cast, as nearly as possible the dimensions of the finished piece, so that but little forging may be needed.

Iron, carbon steel and the other metals and alloys in general use are readily tooled when cold. Hence, we have in general tolerated forging appliances which leave the piece in a shape in which a considerable amount of tooling is needed. But, even for these metals, recent years have developed ingenious methods of forging even complicated pieces so closely to the needed shape as to avoid subsequent tooling, or to greatly reduce it. We have not only the great advances in drop forging, but several different kinds of rolling machines, of the general class to which the Simonds rolling machine belongs.

BRIDGE PINS.

For example, it appeared that manganese steel should be a valuable material for bridge pins, since these need not only great shearing strength, but great hardness. If they wear away the play which arises is extremely injurious to the bridge. We were at once confronted with the difficulty of providing threads on the ends of the pins to hold the lock nuts. The difficulty had hardly arisen when it was overcome by the discovery that Messrs. Wyman & Gordon, of Worcester, had a machine which forges threads on round bars of any size, and apparently accurately enough for this purpose.

COLD SHAPING.

Turning now from this way of evading the hardness of manganese steel by special appliances for working it while hot, we come to appliances for shaping it while cold, despite its hardness. These are, first, emery wheels of various kinds for cutting it; second, hardened carbon steel rollers, dies, etc., which work it cold.

Emery is so much harder than manganese steel that it cuts it with great ease. Indeed, as an observer from the summit of a lofty mountain hardly notes the little hills at its base, their elevation being so trifling compared with his, so the hardness of emery exceeds that of manganese steel so greatly that when cut by emery the resistance of this metal to abrasion excels that of carbon steel much less than when the abrasion is effected by a revolving steel shaft. This is illustrated by Table II.

I may almost say that what the common hardened steel tool is to most metals the emery wheel will be to manganese steel. Just as we turn other metals in the lathe by holding a hardened steel tool against them while they revolve, so we may turn objects of manganese steel by mounting them in like manner, and simply substituting for the hardened steel tool an emery wheel revolving swiftly. So, too, may the stationary tool of the planer, and in some cases the reciprocating tool of the slotting machine, be replaced by the revolving emery wheel, the piece which is to be planed moving past the emery wheel, that which is to be slotted remaining stationary while the emery wheel, driven by belt or gearing, plays up and down.

HARDENED STEEL.

Turning now to means of working rather than of abrading it when cold, this thin wire shows at once that it is possible to work the metal cold to a very considerable extent. This wire has been made by drawing through dies when cold in the common way. It is, however, hardly likely that manganese-steel wire will be widely used, the material offers so much resistance in drawing, is so hard and requires such frequent annealing. After every two drafts it must be highly heated and quenched in cold water.

The great amount of cold working which wire drawing requires may be so costly as to be prohibitory, yet a smaller amount may cost but little. If manganese steel could not be worked cold at all it might be a serious thing. Even the most accurate methods of hot forging bring the metal only approximately to the size desired, for the following reason. The temperature at which the metal is forged while hot must vary considerably. As that temperature varies so does the number of degrees through which the metal must pass in cooling thence to the common temperature; and as the contraction of the metal in cooling is proportional to range of temperature through which it cools, so must the amount of contraction which the metal undergoes in cooling vary. So that no matter how accurately we bring the metal to a given desired shape and size when hot, as we cannot regulate closely the temperature at which we give it that size and shape, so will the size and shape which the metal has after cooling vary. For many purposes this variation may not be serious. But for many others it is extremely serious, not to say prohibitory. Yet, so slight is it that but a very little cold working is needed to compensate for it.

Now it so happens that Mr. SAMUEL JOHNSTON, of 140 Nassau street, New York City, has devised and constructed machines capable of rolling manganese steel and other metallic substances while cold, and with great ease. I have here a strip of manganese steel which was originally throughout its length of the cross-section which its larger end now has. It has been worked down to its present shape while cold, and without annealing. I am informed that this machine can produce pieces of exceedingly irregular shape. With the slight familiarity which I have with it, I find it difficult to set a limit to the shapes which it can produce. As we can turn wooden gun stocks and axe handles in a lathe, so can this machine turn out even most irregular pieces.

It is still too early to assign to these two methods of shaping manganese steel when cold their exact fields. In many cases it is probable that either can be used, as in turning bridge pins and car wheels, in trimming armor plates, and in shaping plow points. In other cases, such as that of car axles, where an irregular cross-section must be given with extreme accuracy, the Johnston machine seems more applicable than the emery wheel.

ESTABLISHED USES.

When we come to the actually well-established uses of manganese steel, I must act the apologist. They are few. In addition to the inertia of custom, which properly leads each to cling to the material which does well enough rather than brave the ills he knows not of, we have the really serious obstacles which the very nature—indeed, the very advantages—of this alloy oppose to its use, and certain personal considerations on which I may touch but lightly.

The death of the senior HADFIELD shortly after the invention of manganese steel, threw on his son the cares of a very large and growing business, in addition to those of the development of manganese steel and of many other extremely promising alloys. There has been lack of laborers, rather than lack of promise of harvest.

The most important single use for manganese steel is for the pins which hold the buckets of elevator dredgers. Here abrasion chiefly is to be resisted; here manganese steel has given remarkable results; and here its use has, I believe, ceased to be tentative. Figs. 1 and 2 show how much better manganese steel resists abrasion than carbon steel. The manganese steel pin, Fig. 2, has endured more than three times as much use as the forged carbon-steel

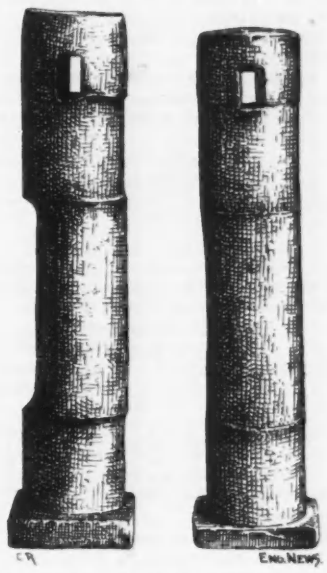


Fig. 1. Carbon Steel. Fig. 2. Manganese Steel.

WEAR OF PINS ON ENDLESS CHAIN DREDGES.

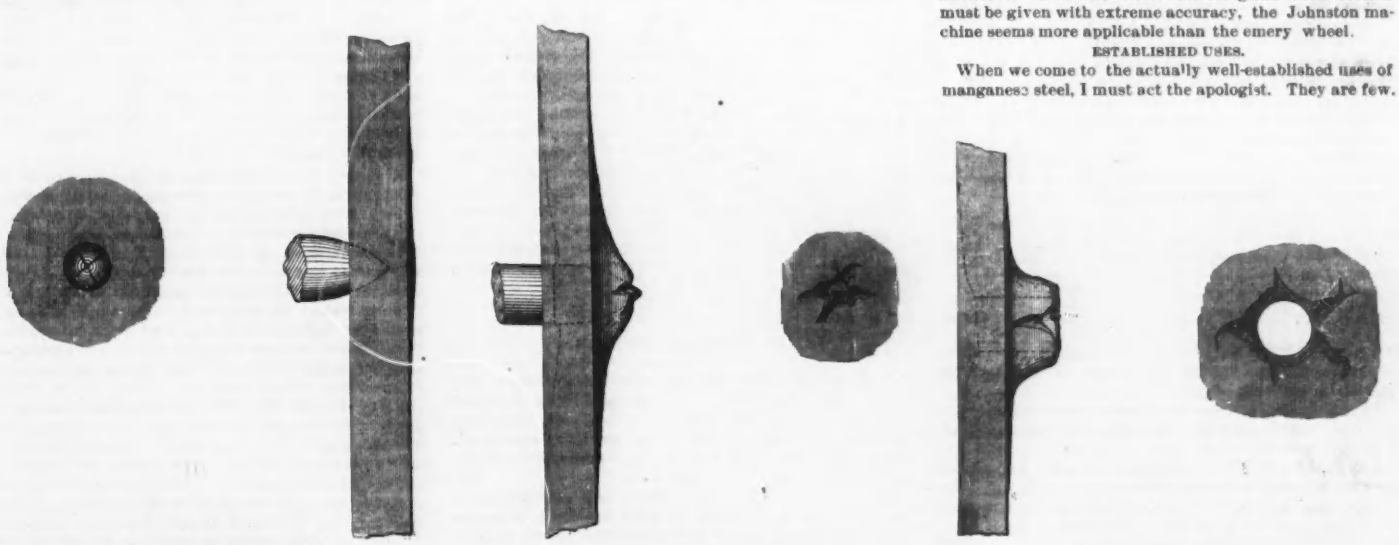


Fig. 3. Manganese Steel. Fig. 4. Carbon Steel. Fig. 5. Wrought Iron.

TESTS OF PENETRATION OF ARMOR PIERCING PROJECTILE AT LOW VELOCITY.

pin, Fig. 1, and yet has been worn away very much less than its competitor. Hard as this 6-in. pin is, it can be bent double cold without cracking.

Another important use is for the links of common chain-elevators. The manufacturer who uses them most reports that they last more than twice as long as carbon steel links.

The Cyclone pulverizer consists of two propeller blades, set end to end in a closed chamber, and revolving rapidly in opposite directions. The ore or other substance to be powdered is dropped between these blades. They are thus subjected at once to severe abrasion and to heavy blows; hence they must be tough and hard. While chilled cast iron is found to abrade slightly less under these conditions, yet it often breaks, causing serious accidents. Manganese steel has been found perfectly safe, and has been regularly adopted.

Besides many smaller uses, a great many points and crossings for both steam and horse railways have been made; but it is not yet known how the wear of manganese compares with that of carbon steel under these conditions.

Car wheels probably offer the most promising use for manganese steel. A car wheel must first of all be so tough and trustworthy that it will not break even under the trying conditions of use; and beyond this, it must resist abrasion; in short, it must have this combination of toughness and hardness which manganese steel offers. Several serious obstacles have retarded the introduction of manganese steel for this purpose, but we see our way pretty clearly to overcoming these completely. And I hope strongly to see manganese steel become *the* material for passenger-car wheels within a few years. I am less hopeful as regards freight-car wheels, because the results are less serious when a cast-iron wheel breaks under a freight train than when it derails a passenger train.

The chief difficulty in the way of introducing manganese steel car wheels has been the extreme hardness of the metal, which made it difficult to turn the tread and to bore the hub true. This difficulty is now well in hand. The tread may be turned by means of emery wheel, the car wheel itself being mounted in a lathe and revolving slowly so as to bring each point in its tread in succession against the emery wheel.

The hub might be bored with an emery cone such as is used successfully for dressing out the conical steel dies through which steel bars are drawn cold. But an objection to this is that the purchaser of a car wheel may wish to bore out his wheel to fit a particular axle after it has left the maker's hands. Hence it will be better to weld or cast into the manganese-steel wheel a center of iron or soft steel, which can be bored readily.

Manganese-steel wheels under a one-horse tram car in Chester, England, were returned after running 80,000 miles. The service under horse-cars is very trying, as the brakes are so often applied, and as so much sand and other gritty matter lies on the rails. The mileage on one of the most important street railways in this country follows:

Maker.	Number of wheels put in.	Number worn out.	Average mileage.
X.....	515	293	7,748
Y.....	78	12	16,373
Z.....	154	14	4,539

Of these three classes of wheels two were of cast iron and one of carbon steel.

I am informed that some manganese steel wheels have run over 300,000 miles each without turning, on a New England railway.

For gears exposed to excessive abrasion, *e. g.*, from grit, manganese steel commends itself.

For safes, also, it should be well fitted, as it can neither be broken by sledging, nor cut, nor drilled.

It is to be expected that manganese steel should make excellent armor plates, for here hardness and toughness should be combined. The plate must be so hard that the shot does not penetrate it, yet so tough that it does not crack and let the water in; and such experimental data as we have indicate that it will fulfill this expectation.

Figs. 3, 4 and 5 illustrate the effects of a shot on manganese steel; on carbon steel containing 0.25 per cent. of carbon; and on wrought iron. The wrought iron plate was completely perforated; the carbon-steel plate was cracked through; three manganese-steel plates received in all four such shots, which in two cases penetrated ½ inch, and in the other two ⅝ of an inch. The manganese-steel plates became somewhat dished by the blows, as is roughly shown in Fig. 3, and in two cases a slight surface crack resulted around the inside of the hole.

A sliding ram had hard steel armor-piercing shot attached to its lower face, and was dropped from a height of 8 ft. upon these several plates, which were supported firmly on timber. The manganese steel plates were 9 ins. square and 0.75 in. thick. The conditions of this test do not, indeed, reproduce those of actual warfare; in the one case we have a great mass moving slowly, in the other a small mass moving swiftly.

PERSONALS.

Mr. A. C. CROSS, of Emporia, Kan., has been elected President of the Missouri, Kansas & Texas.

Mr. W. H. GREEN, of the Piedmont & Danville system, has been appointed General Manager, and Mr. C. GAFFETT, General Superintendent, of the Central R. R. of Georgia.

Prof. A. T. WOOD, Professor of Mechanical Engineering in the University of Illinois, has resigned, to accept a similar position in the Washington University, St. Louis, Mo.

Mr. JOHN W. HILL has been engaged as Consulting Engineer for the improvement of the west district waterworks at Saginaw, Mich. Mr. R. W. ROBERTS is Resident Engineer.

Mr. A. W. STREET, formerly Assistant General Freight Agent of the Michigan Central R. R., has been appointed General Manager of the Hoosac Tunnel line, vice Mr. J. A. GRIER, deceased.

Mr. G. R. FRENCH, Chief Engineer of the Staunton Development Co., and Mr. G. M. WARREN, have entered into partnership under the firm name of French & Warren, Civil Engineers, Staunton, Va.

Mr. H. B. SLAVEN, well known in his connection with the American Dredging Co. and its good work on the Panama Canal, has been elected a director and treasurer of the Nicaragua Canal Construction Co.

Mr. E. A. HOPKINS, Secretary to the Argentine Republic delegation to the Intercontinental Railway Commission, and who had been largely interested in railways in the Argentine Republic, died in Washington, D. C., June 10.

Mr. JOHN LUNDIE, M. Am. Soc. C. E., of Chicago, Ill., has enlarged his office room in the Rookery Building, to carry on business as a consulting engineer. He is contracting agent in charge of the Chicago office of the King Iron Bridge & Mfg. Co.

Mr. L. W. CLARKE has been appointed City Engineer of Chicago, vice Mr. A. W. COOKE, who becomes First Assistant Engineer. Mr. CLARKE was connected with the Lake Shore R. R. for 10 years, was Chief Engineer of the Illinois Central R. R. for 18 years, and for some time previous to his appointment acted as a Consulting Engineer in the South and West.

Col. JOHN ALBERT MONROE, M. Am. Soc. C. E., died at Providence, R. I., on June 11. Mr MONROE was born in Swansea, Mass., graduated at Brown University about 1860, and entering the army he attained high rank as Chief of Artillery under Gens. HOOKER, MCDOWELL and DOUBLEDAY. He was later Chief of Staff of the Artillery Reserve of the Army of the Potomac. In 1879 he was U. S. Assistant Engineer in the hydrographic and geodetic surveys of the Mississippi River, between Cairo and Memphis. He was later one of the engineers of the West Shore Railway and was resident engineer in charge of construction on the Thames River drawbridge, at New London, Conn. He was 54 years of age, and elected a member of the American Society of Civil Engineers on Sept. 15, 1869.

NEW PUBLICATIONS.

—*Brick Pavement.* The Inauguration and Execution of the Work, the Manufacture of Brick, with Tables of Experiments and Tests, to which are added complete working specifications and form for bids, etc. C. P. CHASE, City Engineer, Clinton, Ia. Paper, 5¼ × 7 ins.; pp. 52; illustrated. Price, $1.

This pamphlet is issued at a very good time, as so much paving of this kind is being done and projected. There is consequently a demand for information on the subject, such as is supplied in this publication. The scope is explained by the title, and the several points are treated of in detail. The specifications are very full and complete.

—*The American Republics.*—Bulletin No. 2, Bureau of the American Republics; issued Feb., 1891. Second and enlarged and revised edition, 8vo., pp. 486, maps and views.

Contains a vast amount of boiled-down information and statistics relating to the Central and South American Republics. A very useful book of reference at a time when commercial union with these countries is attracting so much attention.

—*The Official Railway List.* A complete Directory of the Presidents, Vice-Presidents, General Managers and Assistants, General and Division Superintendents, Chief and Assistant Engineers, Secretaries, Treasurers, Auditors, Traffic Managers, General Freight, Passenger, Baggage and Ticket Agents, Superintendents of Telegraph, Purchasing and Fuel Agents, Superintendents of Motive Power, Master Mechanics, Master Car Builders, Foremen of Repairs, etc., of the Railways of North America, and Handbook of Useful Information for Railway Men. Walter D. Crosman, Editor. Chicago, 1891; Railway Purchasing Agent Publishing Co. Cloth; 8⅛ × 4½ ins.; pp. lxxvi + 323; $2.

The contents of this useful little volume are quite completely given in the above title. The book is well bound and printed, and will prove very useful to the men for whom it is intended.

—*Report of the City Engineer, Omaha, Neb.*, 1890.—G. W. Tillson, City Engineer. Pamphlet, pp. 18 and folding sheets of tables.

Included in this report are figures regarding different materials for street pavements, as used in about 25 of the larger American cities. In the classification stone block and asphalt pavements are placed first, cobble stone and brick second, macadam and wood third. The cost of various classes of work done under the direction of the city engineer in 1890 is given in much detail.

—*Report of the Chief of the Division of Forestry for* 1890 B. E. FERNOW. From the report of the Secretary of Agriculture for 1890. Government Printing Office, Washington, D. C.; 9×5¾ ins., pp. 43.

This is the fifth annual report and refers to the scope of the forestry division and the work which it is doing. It is urged that means should be provided for obtaining statistics of the timber resources and consumption. Several pages are devoted to the wood-pulp industry, giving the processes used, number and capacity of mills, etc. Among other matters considered in the report are timber tests, forestry interest and education, statistics of exports and imports and artificial rainfall. The most important publication issued during the year is said to have been the final report of Mr. E. E. R. THATMAN on "The Substitution of Metal for Wood for Railway Ties," which report was reviewed in ENGINEERING NEWS, Aug. 30, 1890.

SOCIETY PROCEEDINGS.

The Atlanta Society of Civil Engineers has been organized at Atlanta, Ga. President, Grant Wilkins; Vice-Presidents, H. B. Baylor and N. W. Davis; Secretary, P. N. Black; Treasurer, C. B. Haines. Directors, R. M. Clayton, B. M. Hall and W. S. Larendon.

Civil Engineers' Club of Cleveland.—At the regular meeting on June 12 Mr. Walter Miller read a paper on "Steam Steering Gear for Lake Vessels," and illustrated with drawings the mechanism by which the greatest accuracy is obtained in turning the rudder any desired number of degrees. This was followed by a brief discussion as to the practicability of applying the same or similar arrangement to cranes and other hoisting machinery.

Prof. E. P. Roberts then read a paper on "Considerations Governing the Choice of a Dynamo," in which the general construction of the dynamo was fully explained, and the good points that should be looked for when making a choice were fully gone over. After a short discussion on this paper Mr. F. C. Osborn gave an account of the recent Convention of the American Society of Civil Engineers at Lookout Mountain.

Western Society of Engineers.—Meeting of June 3 President L. E. Cooley in the chair. Capt. Robert W. Hunt and Mr. George Dorr were elected members. Mr. C. L. Strobel was elected a member of the World's Fair Congress in place of Mr. Don J. Whittemore, resigned. The special committee on the Chicago railway problem was granted a four months' extension of time in which to make further investigations. The report will be presented in September. It was also voted to hold a fall meeting, and the Secretary and Board of Directors were directed to appoint the time and place and complete arrangements. Remarks were made on the expansion of rails by Messrs. Wright, Reynolds and Chanute. The paper of the evening was by Mr. E. L. Corthell, further discussing and answering recent criticisms on his paper on "An Enlarged Waterway Between the Great Lakes and the Atlantic Seaboard" (published in full, with map, in ENGINEERING NEWS, April 18 and 25, 1891). The paper dealt largely with Mr. Williams' criticism favoring the building of the waterway through Canada instead of the United States. Figures were given showing that transportation by railways is cheaper than by canals and arguing from a commercial point the construction of a ship railway across Michigan instead of a canal. The author, who is now in Europe, stated that he was soon to prepare a paper on canal vs. railway rates. A very interesting and instructive talk was given by Mr. J. F. Wallace on the Chicago Lake Front Question, supplemented by a large drawing showing the present condition of affairs, and also by dotted lines and colors the different plans for changing the arrangement of the Illinois Central R. R.'s tracks, already proposed, as well as the plan provided by the bill now before the State Legislature. The history of the matter was given from the date of entrance of the Illinois Central R. R. to the present time.

Engineers' Club of Philadelphia.—Record of regular meeting, May 16, 1891. President Wilfred Lewis in the chair; 56 members and 5 visitors present.

The special object for which this meeting was called was the discussion of the subject of rapid transit. The meeting opened by the presentation of a paper by Mr. John L. Gill, Jr., for Professor H. W. Spangler. The author discussed the question of the transportation of passengers to the center of the city by the Pennsylvania and Reading, the main steam roads; the recent approval

of the Market St. elevated railway ordinance, with a description of the route and general conditions under which this road is to be built and operated. He also referred to the possible construction of other roads in West Philadelphia, and an elevated railway to Tacony. The next paper was by Mr. G. Herbert Condict, a visitor, upon electric railways. He referred to the fact that while electric motive power has a history in this country of about six years, and is only in an early stage of development, over one-quarter of the street railway companies in the United States are already operated wholly or in part by electricity. Mr. T. Carpenter Smith followed with a paper on the subject in question, and Mr. P. G. Salom presented a discussion giving the cost of operating electric railways. There was some further discussion by Mr. T. Carpenter Smith and Mr. Henry B. Seaman, the latter speaking in favor of steam locomotives for traction. The Secretary presented a plan and profile of Market St., from Mr. Samuel L. Smedley, and read general communications from him, wherein he declined to discuss the elevated railway question in Philadelphia in detail on account of his official relations therewith. Mr. Smedley also forwarded a photograph taken of the line of an elevated railway in New York at about the time of construction, showing scarcely anything in the vicinity but desolate building lots and shanties, and another photograph from the same point taken ten years afterward, showing complete lines of magnificent buildings and improvements on both sides of the streets. These pictures were submitted as conclusive proof that elevated railway do not prevent the most elegant and substantial development of property along their lines. Mr. Smedley also presented a copy of specifications and proposals for building and operating the elevated railway on Market St.

The regular meeting was held June 6, President Wilfred Lewis in the chair; 33 members and 3 visitors present. The Secretary presented, for Mr. G. W. Creighton, a continuation of a paper previously presented by him upon the subject of Rail Joints, giving the results of experiments which had been made since the presentation of the original paper. Prof. H. W. Spangler presented a model and specimen illustrating a curious case of combined tension and flexure. The specimen in question was square in section at the ends. A few inches from each end it was enlarged on one side and still further enlarged in the middle on the same side, thus giving a much greater area of metal next to the ends, and a still greater area in the middle. The specimen, which had been broken in tension, had not been broken at the ends, but through the section next to the ends, where there was a large increase in area. Professor Spangler then presented a mathematical discussion, showing that this fracture occurred where it did in accordance with strict mathematical principles. There was some discussion by Mr. C. Barth, visitor, and Mr. John L. Gill, Jr. Mr. Barth illustrated how a rectangular specimen pulled on the line of its axis would be subjected to simple tensile strain, but if pulled off the line of its axis would have a tendency to split open from the side on which it was pulled.

HOWARD MURPHY, Secretary.

Engineering Association of the South.—The May meeting was held May 15, at Earlington, Ky., President John B. Atkinson presiding. The paper of the evening entitled "Coal Cutting Machinery," was presented by Mr. John B. Atkinson, Vice-President of the St. Bernard Coal Co. The paper presented the historical development of coal cutting machinery and a comparative study of American machines as compared with those of England and France. The use of electricity as a motive power was thoroughly discussed and the advantages and disadvantages of the positive feed machines set forth. During the day a very general inspection of the collieries and coke ovens of the St. Bernard Coal Co. was made, and the improved system of coal cutting machinery and hoisting machinery was carefully studied.

The June meeting was held at Nashville, Tenn., June 11, First Vice-President W. L. Dudley and President Jno. B. Atkinson presiding in turn. The program of the evening comprised the following papers: "Some Notes on Mining Operations in the Sewanee Coal Seam," by Mr. J. J. Ormsbee, Superintendent of the Thomas mines of the T. C., I. & R. R. Co., Whitwell, Tenn.; also a paper on "Street and Highway Traffic," by J. M. Heiskell, Assistant Engineer of the Memphis bridge, Memphis, Tenn.; also a paper on "Tests of the Capacity of Sewer Pipe Lines to Withstand Internal Pressure," by R. L. Johnson, Graduate Fellow in Engineering Department, Vanderbilt University. Mr. Ormsbee's paper was devoted to a general description of the character and workings of the Tracy City and Whitwell collieries in the Sewanee coal seam, preceded by a description of the geological formation of the region. The Sewanee mines are located at Tracy City, Grundy Co., Tenn., and have been in operation since 1856, since which date 5,000,000 tons of coal have been mined and 1,400,000 tons of coke made. An average of six analyses of coal from the Tracy City mines shows:

Moisture	1.71
Volatile matter	28.74
Fixed carbon	62.64
Ash	7.52
Sulphur	.18

The mines are worked by the single entry system, and natural ventilation has generally been sufficient; furnaces, however, have recently been added to increase the supply of air. The Thomas mines, also on the same seam, are located at Whitwell, Marion Co., Tenn., and have been in operation since 188 , since which time about 450,000 tons of coal have been mined, and 70,000 tons of coke made. This coal is much firmer than the Tracy City coal, has no cleavage nor conchoidal seam, but breaks into rough irregular lumps. The seam varies from 4 ins. to 7 ft., averaging about 3 ft. The mine is worked on the double entry plan and the split system of ventilation is employed. No firedamp in this mine or the Tracy City Mines has been encountered.

Mr. Heiskell's paper was directed principally to the argument that the economy of street and highway traffic could be best improved by paying attention to improving the vehicle rather than the road surface and to acomplish this recommended strongly the introduction by proper legislation the following features in the construction of vehicles: 1st, width of tire to be dependent on the weight of the load; 2d, length of axle to be depenpent on weight of load in order to insure non-tracking of vehicles; 3d, the difference in lengths between front and rear axle to insure non-tracking between front and rear wheels; 4th, the introduction of springs for heavy-draft wagons.

The paper presented estimates based on quotations from paving companies giving their prices for guaranteeing the maintenance of their pavement for terms of years under present existing conditions and also under conditions to be secured by legislation as to the above improvements in vehicles.

Mr. Johnson's paper presented an account of some experiments conducted at the engineering department, Vanderbilt University, to determine the bursting strength of different sizes of ordinary glazed sewer pipe, with the view to determine the ability of sewer lines and conduit lines made of this pipe to sustain internal pressure without bursting or blowing out the joints. The paper gave an account of the character of the pipe and the materials employed, and the manner of conducting the experiment. The experiment was conducted on three sizes of pipe, viz.: 8, 15 and 24 ins. in diameter, and the results showed internal bursting pressures running from 10 to 18 lbs. per sq. in., the pipe and joints both failing at about equal pressures.

The Iron and Steel Institute.

From Our London Correspondent.

The annual spring meeting of the Iron and Steel Institute was held in London, on the 6th and 7th of May. The meeting was attended with more than usual interest from three causes: Firstly, there was a good deal to be said about the memorable visit to the United States of last year—members meeting and comparing notes—so that there was a great deal more business done in the lobby than in the lecture theatre; secondly, on account of the eminence of the Bessemer medalist for the year; and thirdly, from the high reputation of the new president. Beyond these facts the meeting was certainly not above the average in interest. The first business was the reading of the report of the council, which was largely taken up by reference to the American visit. A list of papers read was given, but this we need not repeat. In speaking upon the visit generally the report said that the anticipation formed that the United States visit would be "alike instructive, agreeable and successful," had been realized to the fullest extent; and indeed the talk in the lobby most amply confirmed the official statement in this matter. Reference was made to the excursion to the Southern States, and the labors of Mr. W. P. SHINN were gratefully referred to. The latter gentleman, together with Messrs. J. F. LEWIS, C. KIRCHOFF and Dr. R. W. RAYMOND have had, as the readers of ENGINEERING NEWS are doubtless aware, testimonials presented to them as a memento of the good offices rendered in connection with the visit.

Sir JAMES KITSON, M. P., who has been president for the last two years, next vacated the chair in favor of the new president, Sir FREDERICK ABEL, D. C. L., F. R. S., D. Sc. Sir FREDERICK many years ago succeeded FARADAY as Professor of Chemistry to the Royal Arsenal at Woolwich. This was in 1852, and he has held the position up till a short time ago, when he retired. The new president is a distinguished metallurgist, although he is best known in connection with his labors on the nature of explosives, a subject upon which he is undoubtedly our highest authority. His first task on taking the presidential chair was the presentation of the Bessemer medal, which this year had been awarded to Lord ARMSTRONG. Lord ARMSTRONG is now 81 years old, but he is still vigorous enough to make a speech of considerable length, as was proved by the way in which he returned thanks for the medal, and that his intellect is as bright as ever requires no further testimony than his contributions to scientific and economic literature. Lord ARMSTRONG is one of the men of whom we, in England, are especially proud. His father was a merchant of Newcastle, and he himself was, for the first years of his life, a solicitor. The law was not to his taste, so he early joined a firm of manufacturing engineers who had comparatively small works on the banks of the Tyne at Elswick. Hydraulic engineering was the first field in which he worked, and his original and important inventions in this branch of engineering are well known. The Crimean war turned his attention to gunnery, and for some time he was at Woolwich in the Government service, but in 1863 he returned to Elswick, and from that time forth has remained in the north. The result of his work has been that the small engineering works with which he first became connected have grown into the enormous establishment at Elswick, where thirteen to fourteen thousand men are employed. Lord ARMSTRONG combines the rare faculty of being a skillful manipulator of men as well as of materials; he has won his present high position by engineering ability, hard work and business tact. He is one of the most amiable and kindly men, and differs chiefly from his great rival, the late Sir JOSEPH WHITWORTH, in never running his head against brick walls.

The Bessemer medal having been presented, the President proceeded to read his inaugural address. This was of more than usual length, and was, we think, hardly equal to the high reputation which Sir FREDERICK ABEL has made for himself. There were no new facts brought forward and the matters dealt with were hardly arranged in harmonious sequence; in fact, the address bore strong evidence of being a hurried compilation. As Sir FREDERICK ABEL is also this year President of the British Association the fact is perhaps not to be wondered at.

There were ten papers on the agenda, but only seven were read, of which the following is a list: "On Tests for Steel Used in the Manufacture of Artillery," by WILLIAM ANDERSON, D. C. L., Director-General of Ordnance Factories; "On Certain Pyrometric Measurements and the Method of Recording Them," by Prof. ROBERTS-AUSTEN, F. R. S., Royal Mint, London; "On the Mico-Structure of Steel," by M. OSMOND, of Paris; "On the Changes in Iron Produced by Thermal Treatment," by Dr. E. J. BALL, Royal School of Mines, London; "On Economical Puddling and Puddling Cinder," by THOMAS TANNER, Mason Science College, Birmingham; "On a Graphic Method of Calculating the Composition of Furnace Charges," by H. C. JENKINS, London; "On the Manufacture of War Material in the United States," by W. H. JAQUES, Bethlehem Iron Works, Pa.

The list was more attractive to read than it turned out in practice. Dr. ANDERSON'S paper was originally intended to contain the new official tests for gun steel which our Government authorities for some time past have been formulating. Unfortunately these tests have not been officially announced, and it is contrary to etiquette for such matters to be made public excepting through the formal channels. Dr. ANDERSON'S paper was, therefore, robbed of its chief interest; but, nevertheless, gave rise to the best discussion of the meeting. This chiefly centered on the question of oil hardening, a much debated subject for some years past. Many engineers attribute pretty nearly all the ills to which ordinance is heir to the oil hardening applied during the progress of manufacture. The chief advantage claimed as resulting from oil hardening—by its advocates—is, that the elastic limit of the material is increased, although the modulus of elasticity would remain unaltered. There is, we presume, no contention on these points, although recent researches tell us that our old notions respecting elastic limit require revision. On the other hand, it is said by those who oppose the system that oil hardening sets up cracks in the interior of the metal, and these becoming further developed during the process of manufacture are a source of weakness to the weapon. Undoubtedly, it is better to have even a low-strength steel without cracks than ever so strong a metal *plus* the cracks. The oil hardeners say that the cracks are found out in the course of manufacture or during test; the anti-oil hardeners reply that that by no means follows; that a gun may hold together, although it has cracks in it, until a critical period in service, and will then go suddenly. On the whole, we should say, so far as the discussion went, that the anti-oil hardeners had the best of it, and we should not be surprised to see the process disappear from the Government program.

Another subject of considerable scientific and practical interest which was broached during the discussion was the relative volumes of liquid and solid iron. Mr. WRIGHTSON gave some very interesting information upon this point. Briefly, it would appear that a piece of cold iron placed in a bath of molten iron will at first sink. As it acquires heat from the surrounding mass it will rise to the surface, and at a cherry red floats some distance out of the fluid, until at last it acquires the same temperature as the bath. The experiments by which the accurate conclusions arrived at were obtained were interestingly described, and are well worth the study of those interested in these matters.

The paper which Professor ROBERTS-AUSTEN had promised was not forthcoming, but in place of it the Professor gave a verbal explanation of the method of calibrating a pyrometer on the Le Chatelier system. It is needless for us to dwell upon the great boon to metallurgists, and, indeed, to those engaged in almost any branch of physical science, which a reliable pyrometer would prove. The time-honored Siemens pyrometer, however simple in principle

and however good in theory, gives but uncertain records, and is, moreover, slow in its application and not easy to use. The Le Chatelier pyrometer was introduced to the British metallurgical world about two years ago, and great things were promised of it. Unlike some other scientific promises, these appear to have been fulfilled in practice, if we may judge by the testimony borne by speakers during the discussion. Sir LOWTHIAN BELL has had one of these instruments in use at the Clarence Iron Works for some time past, and speaks very highly of its practical success. It may be stated that the instrument consists of a pair of platinum and platinum-rhodium wires. These form a thermo-electric couple. One junction of the wires is inserted in the mass of metal and the other in a vessel of liquid of known temperature. The electric current passes through a mirror galvanometer which projects the image of a flame through a fine slot onto a traveling band of photographic paper. The method of calibration to which Professor ROBERTS-AUSTEN referred would be difficult to make clear without the aid of diagrams. Known temperatures were taken, such as the melting points of metals—from lead to palladium—and a curve was thus plotted.

M. OSMOND'S paper on the micro-structure of steel was but a short note on this interesting subject, which, however, is of far too complex a nature to enter upon in a brief notice of this description. The same thing may be said, even perhaps to a greater degree, of Dr. BALL'S paper, excepting that it was much longer than M. OSMOND'S note. Mr. TURNER'S paper on "Puddling" was not a well considered contribution, and we imagine that the author must now regret he put it forward. Mr. TURNER has done so much good and useful work—especially in regard to the use of silicon in cast iron—that it is a pity to see him bringing forward a paper embodying the results of imperfect research. The paper of Mr. JENKINS on "Graphic Methods" would be incomprehensible without the graphic delineations, and these we have not at command.

The last paper was the voluminous contribution of Lieutenant JAQUES, which might be described as a treatise rather than a paper. The author deals with ships, guns, armor, engines, torpedoes, explosives, and, in fact, there is hardly a thing connected with instruments of destruction upon which he does not touch. There is, however, a great deal of very useful information in the paper, and the author is well known to be a master of his subject, for the study of which he has had such exceptionally favorable opportunities.

The autumn meeting of the Institute is to be held this year in Birmingham, the first home and center of the iron trade of England.

New England Water-Works Association.

(*Concluded from page 562.*)

The first day's proceedings of the Association at their tenth annual meeting at Hartford, Conn., June 10 to 12, were given in these columns last week. At the opening session, Thursday, June 11, the following officers were elected for the ensuing year:

President, H. G. Holden, Nashua, N. H. Vice Presidents, G. F. Chace, Taunton, Mass.; C. K. Walker, Manchester, N. H.; F. H. Crandall, Burlington, Vt.; H. W. Ayres, Hartford, Conn.; B. I. Cook, Woonsocket, R. I.; C. R. Dyer, Portland, Me. Secretary, R. C. P. Coggeshall, Fall River, Mass. Treasurer, Hiram Nevons, Cambridge, Mass. Senior Editor, Dexter Brackett, Boston, Mass. Junior Editor, W. G. Richards, New London Conn. Executive Committee, F. E. Hall, Quincy, Mass.; A. F Noyes, West Newton, Mass.; C. W. Morse, Haverhill, Mass. Finance Committee, H. F. Whittier, Lawrence, Mass.; G. E. Winslow, Waltham, Mass.; J. G. Hancock, Springfield, Mass.

The first paper of the morning was entitled "The Risks Taken by a City or Town in Having but One Supply Main," by Mr. J. C. Hancock, Springfield, Mass. Mr. Hancock spoke of the comparatively small cost per capita of duplicating the mains and of the saving both in fire losses and insurance by having a safe supply.

In discussing the paper Mr. W. G. Richards, New London, Conn., thought that it might sometimes be cheaper to use a distributing reservoir with some storage capacity.

A paper was to have been read by Mr. S. E. Babcock, Little Falls, N. Y., entitled "The Use of Oakum and Portland Cement in Joints of Water Pipe under Pressure, as a Temporary Expedient." Mr. Babcock was unable to be present or to prepare his paper.

The report of the Committee on Classification of Water Rates was read by the chairman, Mr. J. C. Whitney, West Newton, Mass. Mr. Whitney stated that experiments had been made by the committee to determine, by meter measurements, the amount of water used by the various fixtures supplied by water-works. The experiments were made with the object of ascertaining what relation exists between the amount of water used by the first or ordinary kitchen faucet and other fixtures. The experiments were made in connection with the Newton water-works. It was found that 600 families with an average of five persons each, the families ranging in size from 2 to 10, used an average of 12,046 galls. per family per year for the first faucet. Five special meters on second faucets showed that the amount of water ranged from 6% to 22% of that used by the first faucet, the average being 14%; 20% was suggested as a fair rate. Bathtubs used 40% to 90%, and 75% was given as a standard. For the second bathtub 20% was given. Coming to water closets Mr. Whitney stated that 8 were covered by special meters, and that fair records were obtained from 37 more. The range was from 25% to 150% of the amount of water used by the first faucet. When good fixtures are used 50% would be a fair rate, but making allowances for poor fixtures 90% was given as a standard. For second closets three meters were used, and the amount of water consumed was 40% of that used by the first faucet, and of this amount 33% was waste. All the closets had self-closing attachments. Set tubs used 25 to 50%, with an average of 35%. The experiments with hose were not satisfactory, as the season was a wet one. A fair rate would perhaps be 90%. At livery stables it was found that of all the water used 78% was for washing carriages and 22% for drinking. The rate recommended per horse was 20% for drinking, 50% for washing carriages without and 75% with hose, these percentages, like all the others, being of the amount used by the first or kitchen faucet. For private stables, with hose for washing, the first-rate faucet was recommended. For work horses, each, 33% of the first-faucet rate was recommended; for cattle, each, 16%; for Chinese laundries, per employee, three times the first-faucet rate.

Quite an extended discussion followed the reading of the above paper. Mr. Holden asked what disposal was made of waste water. Mr. Whitney stated that there were as yet no sewers in Newton. Mr. Holden thought that this largely reduced the amount of waste, and therefore the consumption. On motion of Mr. Hawes, of Fall River, it was voted that copies of the paper be printed separately and three copies distributed to each member. Mr. Billings, Taunton, Mass., said he thought the method employed in making the experiments a good one, but that it should be extended much further in order to obtain satisfactory results. He moved that the committee be continued, and it was so voted.

The next paper was entitled "Three Years' Experience with a Direct-Pumping System," by Mr. G. F. Chace, Taunton, Mass. Mr. Chace stated that according to the MANUAL OF AMERICAN WATER-WORKS there were [in 1888] but 8 direct-pumping systems in New England, which seemed to show that direct pumping was not in favor among the engineers who have designed the works of that section. Mr. Chace reviewed the history of fires in Taunton, where a Holly system of direct pumping has been in use for 15 years, during the last 3 years of which time Mr. Chace has been Superintendent. He showed that the direct-pumping system had proved very effective in Taunton, the fire losses having been very low.

Mr. John R. Freeman was called upon to discuss Mr. Chace's paper. He thought the general opinion was against direct pumping, and that the good results experienced at Taunton were largely due to the efficiency of the water and fire departments.

Topical discussions were next taken up, the first being on the question, "What is the minimum size of mains allowable for water supply?" Mr. Dexter Brackett, of Boston, said that he supposed it now generally considered, and he believed, that for fire service nothing less than 6-in. pipe should be used. He thought that where 4-in. fire streams were used a 6-in. pipe should not be used for a single length of more than 600 ft. In suburban districts a length of 1,000 ft. might be used. Mr. Whitney, of West Newton, stated that at Baltimore 60% of the distribution is less than 6 ins. in diameter while in Boston but 6% is less than 6 ins. in diameter. The fire losses in Baltimore do not seem to compare unfavorably with those in Boston. In this connection Mr. Brackett stated that a great part of the small pipe at Baltimore was laid during the original construction, and has since been supplemented in many streets by larger pipe. Mr. L. A. Taylor, Boston, stated that the water at Baltimore does not corrode or stop up the pipes; that the pipe is not coated, and that he had seen pipe which had been in use at Baltimore 40 years and was still in good condition.

The next question for topical discussion was, "To what extent is the use of water meters desirable?" Mr. Chace, of Taunton, stated that at Taunton 901 metered domestic services gave a yearly revenue of $12.31 each, against $9.37 from 2,253 unmetered domestic services. The rates received per 1,000 galls. were 29.7 cts. against 12.5 cts., respectively.

THURSDAY AFTERNOON.

The session opened with a verbal description of the New Haven Water Co.'s dam at Woodbridge, Conn., by Mr. L. A. Taylor, C. E., of Boston. The description was illustrated by blackboard sketches. The dam was built in 1890. It is of earth, 900 ft. long and 74 in height from the top to the bottom of the deepest excavation, which was over 40 ft. below the natural surface. There is a concrete heart wall, 8 ft. wide at the bottom and 3 ft. at the top, which is backed part of the way with puddled clay.

In the absence of Mr. Desmond Fitzgerald, C. E., of Boston, who was to have read a paper entitled "Dangers Likely to Arise from Building Aqueducts in Form of Tunnels or with Low Grades," the last paper on the program was read. This was entitled "The Relative Taste and Odor Imparted to Water by Some Algæ and Infusoria, and Thoughts Suggested by Studies in this Direction," and was by Mr. F. F. Forbes, Brookline, Mass.

Mr. Forbes' paper was illustrated by a large diagram showing the relative number of various organisms per 50 cu. cms. found in the water at the Brookline reservoirs. The paper was based on personal studies and memoranda made during four or five years. Mr. Forbes stated that he now knows pretty accurately how many organisms of a given kind his consumers will drink without complaint. For instance, with 10,000 uvella per 50 cu. cms. water is very disagreeable, while the same quantity of water may contain 45,000 synhedra and have less taste and odor. The water at Brookline, after passing through the filter galleries, has few growths, the organisms developing after the water has been pumped to a reservoir.

Attention was called to the great importance of biological examinations, as by such means the growth of organisms could be detected by the Superintendent before the water became disagreeable and efforts made to check the growths. If algæ must be developed, try to develop the least objectionable forms. This is possible, since when conditions are especially favorable to the growth of algæ the first form that appears starves out all others.

The desirability of metering the whole supply to a manufactory, or of separating the ordinary and the fire supply, was next discussed. Mr. John R. Freeman was in favor of such separation, owing to the fact that the demand for water in case of fire is so much greater than for ordinary use that a meter is almost sure to get out of order if a fire supply passes through it. Secretary Coggeshall was also in favor of separating the two supplies.

THURSDAY EVENING.

The evening session was devoted to topical discussions and business. Messrs. Hathaway, of Springfield; Ellis, of Malden; Chace, of Taunton, and Secretary Coggeshall all spoke in favor of the inspection of fixtures to prevent waste.

The old question regarding the ownership of meters was announced for discussion. Mr. Whitney said that in Newton 2,000 meters in house use are rented at $2 a year. Mr. Whitlock stated that in Waterbury a meter rental is charged only when the amount of water used is below the minimum, in which case 10% of the cost of the meter is added to the water rate.

In a discussion regarding service pipes, Messrs. Richards, Coggeshall and Fuller favored lead pipe. Mr. TENNEY preferred cement-lined wrought-iron pipe.

At 9:35 the convention adjourned. Friday morning members of the Association visited the reservoirs of the Hartford water-works under the escort of the Water Commissioners.

THE EXHIBIT.

Excellent rooms under the charge of Mr. S. N. Benedict were provided for exhibits of water-works appliances. The number of exhibitors was not large, but those present made a very creditable showing. The following had exhibits:

Standard Thermometer Co., Peabody, Mass.; Perrin, Seamans & Co., Agents for the Lawrence (Mass.) Machine Co.; Henry R. Worthington, N. Y.; Ross Valve Co., Troy, N. Y.; R. D. Wood & Co., Philadelphia, Pa.; Peet Valve Co., Boston; Chapman Valve Co., Indian Orchard, Mass.; Holyoke Hydrant Co., Holyoke, Mass.; Taunton Locomotive Co., Taunton, Mass.; Walworth Manufacturing Co., Boston; National Meter Co., New York; Fairbanks & Co., Boston; Smith & Anthony, Boston; Horner Manufacturing Co., Holyoke, Mass.

Master Car Builders' Association. Annual Convention at Cape May, N. J.

(*Concluded from page 565.*)

At the opening session on Thursday, June 11, the Nominating Committee reported the following list of officers for the ensuing year: President, Jno. Kirby; Vice-Presidents, E. W. Grieves, Jno. S. Lentz, T. A. Bissell; Executive Committee, in place of three members whose term of office expires, R. C. Blackall, E. Chamberlain, F. D. Casanave; Treasurer, G. W. Demarest. All these are re-elections. At a later session it was voted that the secretary cast the ballot of the Association for these nominees, so the officers of the Association stand the same as for the year just closed. Mr. Wallis announced that the Pennsylvania R. R. would place a special train at the disposal of the members to take them on an excursion to whatever point they chose. It was decided to go to Atlantic City on Saturday morning.

RULES OF INTERCHANGE.

The discussion of the Rules of Interchange was then resumed, the point of interest being Mr. Waitt's proposal to increase the extent to which the owner should be responsible for parts of cars failing through ordinary wear. The Convention was in a less combative mood than the day before, and it was finally voted unanimously that owners of cars should pay for replacing roofs lost off on account of decay, worn out brakeshoes and journal bearings, and broken truck bolsters, body bolsters, spring

planks and truck springs when the breakage is not caused by wreck. This is in addition to the defects for which owners have hitherto been held responsible. The only other changes of importance were the abolition of the rule by which 10% extra is added to the bill for repairs on private cars and some amendments to the schedule of settlement prices for cars destroyed. The alterations in this latter are the addition of a rate of $300 for box-car bodies 34 ft. long and over, the addition for stock cars having feeding or watering attachments of $25 for each, and the provision that when the journals of these cars are 4 ins. or more in diameter, $25 shall be added to the settlement prices for the bodies. It was also recommended that, besides the above, $15 be added to the settlement price for trucks when a car had journals 4 ins. or over, and there was a good deal of sentiment in its favor, but it was finally defeated. A well-earned vote of thanks was awarded to the Arbitration Committee, and after some incidental business, the reports of further committees were called for.

WHEEL GUARANTEE.

The report of the Committee on Wheel Guarantee, abstracted in our last issue, was presented together with a resolution from a committee of the Wheel Manufacturers' Association, stating that as no conference had yet been held between the committees from the two associations, the committee should be continued to report at the next annual meeting of the Association. This action was taken without discussion.

BEST METAL FOR BRAKESHOES.

Chairman Rhodes, of the Committee on Brakeshoes, then gave the report, which was briefly summarized last week. In addition he showed the accompanying diagrams, which summarize the results of the shop tests on brakeshoes of various metals with the machine illustrated in ENGINEERING NEWS of May 31, 1890. A chilled wheel was run at a uniform speed corresponding to 20 miles per hour, and the brakeshoe to be tested was pressed against the wheel with a pressure of 100 lbs. per sq. in. Each shoe was 4 ins. long and 1 in. wide. Shoes of six different materials were tested in this manner, each shoe being given a 10-minute test. While the run was in progress the amount of friction was carefully weighed and was averaged for each minute of the run and for the whole run. At the end of the 10 minutes the loss of weight of the shoe by wear was also determined. The relative order of superiority in friction or "holding power" and in ability to resist wear was as follows:

Rank in holding power.	Average friction in three 10-minute tests, lbs.	Rank in resisting wear.	Average wear per test, grains.
(1) Wrought iron.....	88.8	(1) Hard cast iron†....	15⅝
(2) Soft cast iron	79.4*	2) Malleable iron	17⅛
(3) Medium cast iron..	74.3	(3) Wrought iron.....	22⅝
(4) Hard cast iron †....	72.6	(4) Medium cast iron..	140½
(5) Soft c'st i'n (gro'v'd)	72.2	(5) Soft cs't i'n (gro'v'd)	170
(6) Malleable iron.....	67.7	(6) Soft cast iron	192½*

*Average of 2 tests. †Not chilled, but of the hardness of ordinary small car castings.

The wear of the chilled wheel did not prove great enough to be measured in the time during which the tests were continued, and does not seem likely to be of much practical importance. Similar tests were made with steel-tired wheels, but no determination of value of the wheel wear could be made.

The shop tests showed that great variations in the friction of the shoe took place; and if this was the case in the shop, with a wheel mounted in fixed bearings and everything arranged for great accuracy, it was plain that the greatest care would be required in the proposed road tests or else the results obtained would be too variable to draw practical conclusions from. For these and other reasons it had not been possible to make the road tests which were at first planned. Before these could be made it would be necessary to have the co-operation of the managers and a fund would have to be raised in some way to cover their expense. A vote of thanks was awarded the committee, and, despite their appeal to be relieved, they were reappointed, Mr. J. N. Barr taking the place of the late B. K. Verbryck.

JOINT INSPECTION.

The substance of this report and the committee's recommendations were given last week. The report was accepted with little discussion and a letter ballot was ordered on the standards recommended.

AIR-BRAKE STANDARDS.

This committee's report (abstracted in our last issue, had already been acted upon as far as the question of rules for the interchange of air-brake cars was concerned. It only remained, therefore, to consider the book of instructions to employees which was recommended for adoption. Here came in an example of the wisdom of the innovation by which all the reports of committees are printed and placed in the hands of the members a week in advance of the convention. Examination of the book showed it to contain several serious errors, which were pointed out at length. It was finally voted to refer the book to a committee to report at the next meeting.

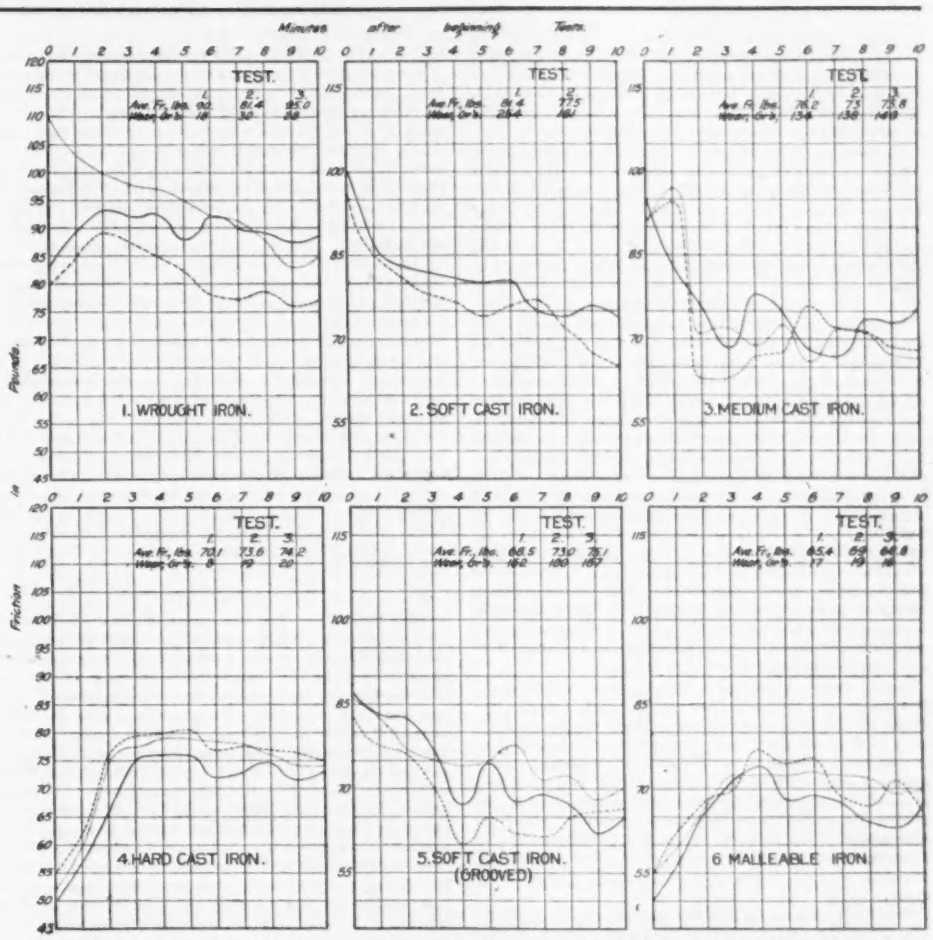


DIAGRAM OF HOLDING POWER OF BRAKESHOES OF DIFFERENT MATERIALS AS DETERMINED BY SHOP TESTS.

(Pressure on shoe constant at 400 lbs., speed constant at 20 miles per hour. Time of each test, 10 min.)

STANDARDS FOR M. C. B. AUTOMATIC COUPLER.

This committee's report (also given last week) had been awaited with much interest; but it came so late in the Convention that the members were in a mood for business and not for discussion. Nevertheless, it took some time to decide what to do with it. There were a few members who would have been glad to have followed up the President's advice, recommending a limitation to five makers; but they were aware that, in the present convention at least, there was no chance of carrying such a motion and they wisely held their peace, although Mr. WAITT ventured to say that, "the country is being flooded with a variety of types of the M. C. B. coupler, some of them good, some of them miserable. It is time some weeding out was done." It was finally voted that the gages and templates recommended should be issued by the Executive Committee for trial by the members; also that a committee should be appointed to consider "whether there are any further standards or limits, or any change desirable in the M. C. B. type of coupler" and report at the next convention. It is plain that this cautiously worded motion gives a pretty broad commission to the appointees; and if the right men are put on the committee, an interesting report may be expected next year.

JOURNAL-BOX, BEARING AND LID.

The motion to submit the new journal-box, bearing and lid for 60,000-lb. cars (illustrated last week) was carried without opposition, as was the proposition to ballot on a lid of practically the same construction for 40,000-lb. cars.

This was the last of the committee reports, and the remaining business was disposed of in short order. A proposition of the Southern Railway Club that the M. C. B. Association employ experts to design a set of standard cars was delivered to the tender mercies of the executive committee. The committee on correspondence and resolutions confined its expressions of gratitude to the daily *Northwestern Railroader*, omitting all reference to the Stockton Hotel management, for which no one was sorry, but neglecting to acknowledge the Pennsylvania Railroad's courtesies and the entertainment provided by the supply men. The place for holding next year's convention was informally discussed, and Martha's Vineyard, Saratoga, Boston, Cleveland, Alexandria Bay and Chautauqua were among the points proposed, seeming to find favor in about the order named. While this was going on the motion for final adjournment was made, but as it was about to be put the chronic interrupter spoke up and there was no more chance to call for a vote. The adjournment which took place, therefore, was practical and effectual, but not formal. So, theoretically, the association is still in session, but practically its members are scattered to the four winds, not to assemble again until the second Wednesday in June, 1892.

American Society of Mechanical Engineers, Semi-Annual Convention at Providence, R. I.

Not since 1883 has the American Society of Mechanical Engineers held its summer meeting so late as in this year, and it is safe to say that no meeting of the society has ever opened with a more general feeling of warmth on the part of the members present. The Narragansett Hotel was hot, the convention hall was hotter, and the only redeeming feature in the temperature was the cool ride up the Sound on the steamer *Connecticut*, of the Providence line, by which route most of the members from New York and the West arrived.

At the opening session on Tuesday morning, June 16, an address of welcome was made by Charles Sidney Smith, Mayor of Providence. He gave statistics of the manufacturing industries of Rhode Island, showing that not less than $735,000,000 per annum of commercial exchanges are required in carrying on the manufacturing industries of the state. While cotton and woolen manufactures are the most important, Providence has mechanical industries of almost every sort. She is improving her public works by a complete system of railway terminals, a great trunk sewer and about a mile of new wharf frontage. The U. S. Government is excavating a ship channel which will enable vessels of larger draft to reach the city. A western paper, which estimates the relative rank of cities by the population dependent upon each placed Providence ninth in a list of American cities. She herself does not claim this rank in population but in mechanical matters she claims to be first. She is now often referred to as the second city of New England, and her citizens aspire to make her some day the manufacturing metropolis of the six states.

President R. W. Hunt replied to the speech of welcome, saying that the best evidence of the society's appreciation of the hospitable invitation extended by the citizens of Providence was the number who had accepted it. He believed the attendance at this Convention was not only larger than at any previous meeting of the society, but was larger than any meeting of any engineering society ever held in America; and he risked little in saying it was even larger than had ever attended a meeting of any single engineering society in the world. The society looks to Provi-

dence not only as the representative mechanical city, but as the home of Corliss, who did as much as and perhaps more than any other American engineer to make our engineering profession respected throughout the world. Here, too, was the scene of the earliest labors of one of the society's best loved members, Alexander Holley.

Turning to the members, President Hunt thanked them for the honorable office conferred upon him, and warned them that the life of the society depended upon its papers and discussions, 'as the troubles of some of our sister societies have shown." The members of the society must do the work; without their labors the best efforts of the officers count for nothing. The reading of papers was then begun.

TWO ROPE-HAULAGE SYSTEMS.

In this paper Mr. R. Van A. Norris, of Wilkes Barre, Pa., described a system of cable traction adopted by the Susquehanna Coal Co. for hauling about 600 empty coal cars per day up a grade of 1% to 7% and around a reverse curve, a distance of about 600 ft. An overhead wire cable was used, as there was one grade crossing over which a mine locomotive had to run. Another system was adopted by the same company for hauling about 500 loaded 3-ton cars per day from the breaker to a dirt plane. The chief interest in this paper centered in some of the details of construction. One of especial ingenuity was a "spring hub" inserted in the large gear wheel which drove the cable. The main wheel was loose on the shaft, but was provided with lugs which projected into a chambered hub keyed to the driving shaft. Three heavy springs, each closing with 2,000 lbs., were interposed between the lugs and the hub, as shown in Fig. 1. This allowed a motion of 4 ft. on the circumference of the 6-ft. rope driving wheel to take up the shock in starting.

In the overhead system the rope is cut and a link for attaching a chain for pulling the cars is inserted about once in 200 ft. In the other system a brass segmental-cone grip is used with success. There was a brief discussion of not much importance. While the paper had many points of merit it described an unusual piece of work carried out under special conditions and not likely to be duplicated in many places; moreover, it required considerable study to appreciate the special conditions of the problem under which the designer of this system had worked. The interest it excited, therefore, was not very great.

The brief paper on "A Belt Dynamometer," by Mr. S. P. Watt, which we reprint in full elsewhere, excited no discussion. It was followed by Mr. G. I. Alden's paper on "A New Belt-Testing Machine." This machine consists briefly of two pulleys over which the belt is run. To the driven pulley is attached an automatic absorption brake; and recording mechanism is provided for regulating the number of revolutions of the pulleys, the slip of the belt and other data needed.

In discussing the machine, Mr. Wm. Kent said that it was probably all right and he for one should wait with much interest to see what results would be obtained by it in belt testing. Engineers get their ideas of the amount of power a belt is transmitting very much magnified. In one case two experts (!) swore in court that a certain belt was transmitting 18 to 21 HP. while measurement with a Prony brake showed that 7 HP. was the actual amount transmitted.

TEST OF A TRIPLE-EXPANSION ENGINE.

This engine, which many of the members afterward examined at the Narragansett Electric Light Co.'s station, was designed by Remington & Henthorn, of Providence, and built by E. P. Allis & Co., of Milwaukee. It was indeed quite a triumph for Wisconsin to ship such a piece of machinery to Rhode Island. The engine has the Reynolds-Corliss valve gear and a rotative speed, unusually high for a Corliss engine, of about 100 revolutions per minute. An independent engine was used to run the air pump and condenser. The total energy developed averaged 532 indicated HP. and 12.94 lbs. of steam per I. HP. per hour at 125.2 lbs. average pressure was used. Of the total steam used 14.33% was used in the jackets. The entrained water by calorimeter test was 7.39%. The author thought that the presence of this considerable amount of water "most seriously affected the economic action of the steam with which it was mixed." Prof. Jacobus pointed out, however, that tests by Prof. Denton had shown that entrained water affects economy little, except by displacing a certain amount of steam.

This concluded the papers for the morning session, and some current business was next taken up. The reports of the tellers, Messrs. Nason and Baldwin, showed that Sir Henry Bessemer and Henry l'Eaute, of Paris, had been elected to honorary membership; the total additions to the grade of member were 101, of which 96 were newly elected and 5 were promoted from the junior grade. There have also been elected 4 associates and 36 junior members, making the total additions to membership 141. It was announced that at the annual meeting next fall an amendment to the constitution will be voted on, by which the nominating committee will be instructed to name two candidates for each office vacant.

The report of the committee on standard methods of testing materials was called for. Mr. G. C. Henning, of the committee, reported progress and stated that over 500 letters had been sent out; and another appendix to the report had been prepared and was now ready for distribution. This contains some valuable matter on the subject in hand from Russian and German sources including an investigation of the comparative elongation in test pieces of different shapes, by Prof. Belelelubski, of St. Petersburg, is of special interest. In answer to the statement that a committee of the American Society of Civil Engineers was working on the same subject, Mr Henning said that the chairman of the committee of the Civil Engineers' Society had made overtures for co-operation, and there was no doubt that a joint consideration and a joint report would be had. President R. W. Hunt, who is a member of both societies and a member of the committee on standard tests of the Civil Engineers as well, said that he blushed as a civil engineer, but he swelled with pride as a mechanical engineer, over the fact that there was not the slightest danger of the Civil Engineers' committee making a report in advance of that from the Mechanical Engineers. The final report from the Mechanical Engineers' committee, Mr. Henning said, would probably be ready by the November meeting.

The committee appointed at the Cincinnati meeting a year ago to formulate a standard system of testing locomotives reported progress. The committee on standard units of measurement reported resolutions, action on which was postponed. Messrs. T. J. Borden, T. S. Miller, Robert Allison, Jno. Thomson and F. M. Wheeler were appointed a nominating committee and adjournment was then taken until evening.

TUESDAY'S EXCURSIONS.

Notwithstanding the overpowering heat of Tuesday afternoon, the members assembled to a man at the Union depot after dinner, where a special train was in waiting to carry them to the works of the Gorham Mfg. Co., at Elmwood, one of the newer suburbs of Providence. The Gorham Co's works were formerly located near the heart of the city, but a year ago this month the works were removed to Elmwood. The buildings erected by the company at this place are worthy of the fine work which is carried on within them, and that is no light praise They are constructed throughout on the slow-burning system, although the same pains has not been taken in guarding against fire as in the textile factories, where the hasard is so much greater. The slow burning system of building is still none too well known outside of New England, and it was fortunate that so good an example of it was presented for the inspection of the visiting members. The plant is of immense size. Over an hour spent there was not sufficient for the party to do more than make a very hasty tour of the works. On leaving, each lady of the party was presented with a souvenir spoon.

From there the visitors were taken to the Nicholson File Works; and in their tour through this establishment, they witnessed the whole process of file making, from the bar steel to the finished files, packed for shipment. Of course the process of greatest interest at these works was the file cutting, all of which, it is almost needless to say, is done by machines, striking many hundred blows a minute. It is not often that female labor is employed in a machine shop; but at these works nearly all the file cutting machines working on the smaller sizes of files are operated by girls, who seem very expert in their work. More remarkable, however, is the fact that the inspection of the file blanks after they are ground and polished ready for cutting is done by one girl, whose acute sight detects with marvelous quickness and certainty the least flaw in the surface of the metal. After cutting, the files are hardened by heating them in a bath of melted lead to a bright red and plunging them in brine at a temperature of 90° to 110°. The class of work done at this place was much more familiar to the visitors than that done at the Gorham works, and they found much to commend in the plant and its method of operations.

A short visit was then paid to the Rhode Island Locomotive Works, which seemed to have considerable work under way. Locomotives for the Toledo, St. Louis & Kansas City and for the Wabash were among those noticed ready for shipment or near completion. Of course, builders of locomotives and heavy machinery in New England labor under disadvantages compared with firms nearer the coal and iron supplies; the Rhode Island Works are further handicapped by the fact that the plant is somewhat antiquated, compared with that of some of their competitors in the Middle States.

From this point the visitors were taken by omnibus back to the hotel, and the reading of papers was resumed at the evening session.

ECONOMY OF SIMPLE AND COMPOUND ENGINES.

The first paper of the evening was one by Prof. Jacobus describing experiments on the comparative economy of simple and compound condensing Corliss engines, each expanding about 16 times. The summary of the results was as follows:

	Single.	Compound.
Total horse power	141.5	145.9
Revolutions per minute	71.82	49.23
Ratios of expansion with initial steam pressure of 127 lbs.	15½	15½
Pressure of steam in lbs. above atmosphere	106.3	127.5
Number of degrees that steam is superheated	5.5	3.0
Vacuum in inches of mercury	27.5	27.9
Steam per hour per horse power	20.35	13.73

This shows an economy of nearly 30% in the compound engine over the simple engine. A part of this is due, however, to the fact that the single cylinder had 7% clearance, and the compound engine only 1%, "reduced to the basis of its total range of expansion taking place in the low cylinder."

Prof. Peabody criticised the paper rather severely, saying that the only way to compare two engines and get results of any value is to work each of them with the conditions under which it can do its best work. In this case, of course, the engine gave a poor result, for the steam was expanded 15½ times instead of 8 or 10 times, which would have given the maximum economy. Prof. Jacobus spiked this gun by saying that the test was not intended to show a commercial comparison between the simple and compound, but simply to show how much better results were obtained with high expansion ratios when the steam was expanded through two or more cylinders. Mr. F. M. Wheeler called attention, however, to the fact that whether the single-cylinder engine could have done better under other conditions or not, her performance in generating a horse power with but 20.35 lbs. of steam is remarkable. In New England, where best practice in single-cylinder Corliss condensing engines is to be found, the average steam per horse power is 22 to 24 lbs. The economy of the compound is hardly as remarkable, for there are not a few compounds which in regular service are using 15 lbs. of steam or less per horse power hour.

FLEXURE OF ELASTIC RINGS.

This paper, by Prof. DeVolson Wood, was a mathematical discussion; and, although it was put before the members by the Secretary in as interesting a shape as possible, none ventured to pick any flaws in the demonstration.

THE PREMIUM PLAN OF PAYING FOR LABOR.

This paper elicited by far the longest and hottest discussion of any thus far presented. The author first described the commoner systems of paying for labor in vogue, the day's-work plan, the piece-work plan, and the profit-sharing plan, and gave the current objections to each.

Under the premium plan, the number of hours which should be consumed by an ordinary workman in doing a given piece of work is determined as closely as possible. The workman is then paid a certain sum per hour, and for each hour saved he is paid a premium somewhat less than the hourly rate of wages. For instance, if the time required by an ordinary workman working in the ordinary manner to make a given piece of machinery is 10 hours, he may be allowed 30 cts. per hour for his time and a premium of 15 cts. per hour for each hour he can save in doing the work. If he succeeds in doing it in 7 hours, his wages will be 7×30 cts. = $2.10 time allowance $\times 3 \times 15$ cts. = 45 cts. premium allowance = $2.55, or an average rate of 36.4 cts. per hour. At the same time the cost of the labor on the piece to the manufacturer is reduced from $3 to $2.55. The author, Mr. F. A. Halsey, of Sherbrooke, P. Q., "believes that judiciously administered, this plan will produce a larger output and cheaper work, and at the same time pay higher wages than any other whatsoever."

The discussion was opened by Mr. J. P. Hawkins, who saw nothing in the premium plans; to his mind it was of a piece with all these various schemes to substitute some peculiar system in place of open and fair dealing between man and man. But the most important fact which he brought out was that the high wages and high profits which this plan promises will soon be cut down by competition. The consumer will demand lower prices, and will get them, too. He believed the piece-work system was the best yet devised; the premium plan was really the piece-work system in disguise; and wherever introduced, the ultimate result will be the adoption of the piece-work system.

Messrs. Davis and Webber also spoke in favor of the piece-work system, and then Mr. Wm. Kent defended the premium plan proposed by Mr. Halsey with a vigor and earnestness which elicited hearty applause. Mr. Halsey had unfortunately given no instances of the actual operation of the premium plan, but Mr. Kent stated that on Mr. Halsey's suggestion he introduced the plan three years ago in the works of the Springer Torsion Balance Co. and the resuls had been exceedingly gratifying. He admitted that when no further reduction in the time in which a piece of work can be done is possible, the plan becomes practically the piece-work system. As long as there is room for further increase in efficiency by the workman, however, the premium plan is the best yet suggested. Messrs. Balland and Supplee referred to Mr. Towne's paper on gain sharing, read at the Erie meeting. This is similar to the premium plan, except that in the latter case each workman is independent, while in the gain-sharing system the premium is divided among a group of men. The gain-sharing system has been in use at the Yale & Towne works since 1889, and with great success.

The discussion was continued by Messrs. Gantt, Almond, Norris and others, and, as is usually the case when questions of this sort are brought up, branched off into trusts, strikes, competition and kindred questions.

Then Mr. Ashworth rose and gave the members some plain truths in a way that brought out a storm of applause.

This question will never be settled and the workman will never be satisfied with his treatment so long as the wage plan is arranged and the prices are fixed by the employer alone, and why should they? We boast of the intelligence of our workmen; but it is an insult to their intelligence to expect that they will be satisfied with a one-sided bargain. The only fair method is, say to the workmen, "Send your representatives to us and let us decide this wage question as between man and man."

After some further discussion by Mr. Almond and President Hunt, Mr. Halsey closed the discussion briefly, saying that the premium plan was not intended to compete with the Golden Rule. He cautioned the members that the premium plan would meet with little favor from workmen at the start until they had experienced its benefits, and that it was better to be liberal with the time allowance than the premium allowance.

APPLICATION OF HIRN'S ANALYSIS.

Prof. R. C. Carpenter's paper on "Applications of Hirn's Analysis to Engine Testing" described the methods pursued in engine testing at Sibley College, Cornell University. He also described calorimeter tests of the steam remaining in the clearance spaces of the cylinder during compression, which showed that the steam was practically dry. Written discussions of this paper were presented by Professor Thurston and Professor Peabody. Professor Sweet described some curious experiments by Willans, an English builder of compound engines, which tended to show that if once the interior walls of the cylinder were dry, they remained dry, but if once a film of water formed on the interior of the cylinder, it condensed more water and kept the walls wet. Professor Alden described a singular indicator card which tended to confirm the above theory. Professor Peabody then presented his paper on "Applications of Hirn's Analysis to Multiple-Expansion Engines," which concluded the papers for the evening.

Mr. F. M. Wheeler gave notice of amendments to the constitution, to be acted on at the annual meeting, increasing the initiation fee from $15 to $25, the annual dues from $10 to $15, and the fee for advancement from the junior grade from $5 to $15. He explained that the increasing expenses of the society made an increase in the dues necessary. From 10% to 20% of the members are paying additional dues voluntarily. The Council reported in favor of referring the resolutions reported by the Committee on Standard Units of Measurement back to the committee for further consideration, and it was so voted. The session was then adjourned.

CALORIMETERS.

The first paper on Wednesday morning was a long one by Prof. R. C. Carpenter, describing various experiments on calorimeters. There were some interesting and important points in this paper, although it might have been much condensed with material advantage to the society's pocketbook. The experiments seemed to show that calorimeter tests are not wholly reliable as an indication of the quality of steam, on account of its varying character in different parts of the steam pipe. In testing the different types of calorimeters, it was found that a simple steam separator gave results about as accurate and reliable as the barrel calorimeter commonly used, and of course with a great deal less trouble. For ordinary commercial use it seems to be about the best form of calorimeter yet devised. Discussion on the paper was brief.

JET PROPULSION.

In this paper Prof. J. BURKITT WEBB told of an experiment reported to him by one of his former students, which showed that the reaction of a jet of water at 100 lbs. pressure was exactly the same whether the jet issued in oil or in water. The interest of this paper lay in its bearing on the astonishing claims made for jet propulsion by Dr. WALTER JACKSON, of New York City, and his associates. The essential idea of the system advocated by him was that the greatest efficiency would be obtained by reducing the size of the jet and increasing its velocity to the utmost practical limits. This is exactly contrary to the accepted theory of hydraulic propulsion; and the only possible chance which the system had of practical success rested on the theory that when water issued from the orifice with great velocity it acted to some extent like a solid bar, reacting against the surrounding water as against a fixed fulcrum.

The experiments described by Prof. WEBB proved that this supposed greater reaction of the jet when issuing in water at high velocity simply does not exist. It may be noted here that some of the capitalists who put up their money to aid Dr. JACKSON'S scheme were induced to do so by experiments similar to those described by Prof. WEBB, but resulting in just the contrary manner.

After a brief but interesting discussion, Prof. WEBB read his second paper on the performance of a steam reaction wheel. The paper discussed the theoretical requirements for efficiency in such a wheel. The most important fact brought out was that the form of jet exerts a great influence on the possible efficiency of the wheel. The theoretical steam consumption at 70 lbs. pressure would be 60 lbs. per H. P. hour. Several attempted to discuss the paper, but little new light was shed on the subject. In closing Prof. WEBB said that a steam reaction wheel labored under a disadvantage, and a steam turbine was necessary to get the best results. Probably this will yet be developed to be a very economical form of motor.

Before proceeding further with the reading of the papers the President announced a recent action of the Council. After congratulating the society upon the fact that it as a body could obtain a welcome in places from which for business reasons the members individually would be excluded, he stated in substance that to avoid the very appearance of evil it was deemed wisest for members having cameras with them to leave them at the door of the factories visited on the society's excursions.

Some topical queries were then taken up, No. 84, as to the speeds of hot-air engines, was answered by a report of experiments on a hot-air pumping engine showing speeds varying from 120 revolutions to 14 revolutions. No. 85, as to possible speeds of Corliss valve gear was answered by a description of a Corliss engine in the wire rod mill of the Trenton Iron Works which regularly runs at 160 revolutions per minute. The engine was first run at 150 revolutions, contrary to the advice of the makers. The valve gear soon wore out, and a new and heavier one was put in, since which time the engine has run regularly at 160 revolutions without trouble. This brought out the question why Corliss engine builders stick to slow speeds; but no one ventured a reason.

HEAT TRANSMISSION THROUGH CAST-IRON PLATES PICKLED IN ACIDS.

From this paper, by Mr. DANIEL ROYSE, of Ithaca, it is to be concluded that interest in this process, first proposed by Prof. THURSTON for retarding heat conduction from steam engine cylinders, is still alive at Sibley College. The present paper contained some mathematics, half-dozen pages of tables, and wound up with the following paragraph, which really contains the important fact of the whole paper, that it is the varnish and not the pickling which reduces the conductivity:

It is expected that when, as is now proposed, this treatment is applied to the surfaces bounding the clearance spaces of a steam-cylinder, the extent to which the iron, so treated, will store and restore heat, introduced into the engine by the steam will be diminished about 40%, and thus some practically useful reduction of the internal wastes will be effected. In the engine the varnish is relied upon to retard this interchange of heat, and the alteration of surface produced by the action of the acid is expected to render the varnish more adhesive and permanent.

Prof. PEABODY said it did not follow at all that because varnishing a plate reduced the conductivity 40%, varnishing the cylinder head of an engine will reduce the extent to which the iron will store and restore heat by 40%. It may be half this and it may be double.

Mr. NASON said that while the author states the plates to have been of varying thickness, no allowance seems to have been made for this so far as the tables show. Also no means was taken to insure the same amount of circulation over the surface of the plate in all the tests; this as is well known, greatly affects the conductivity.

FOUNDRY PRACTICE.

Topical query No. 86 was

Which is better economy in a foundry cupola: to melt rapidly, producing a relatively cool iron, or to melt more slowly, producing hotter iron?

Mr. W. O. Webber said: We average about 100 tons of castings per week, and have been melting at the rate of about 8 tons per hour, using 1 lb. of coke to 7½ lbs. of iron and getting a total product of 75¾% of the metal charged. To increase the output on Jan. 10 the rate of melting was raised to 11½ tons per hour and from that date to May 29 the average ratio of iron melted to fuel used was 9½. In the same time the efficiency of the cupola remained practically stationary, falling only to 75% from 75¾%. The change effects a saving of about $3 per ton of castings in labor alone. The rate of driving was increased by using a stronger blast (14 oz.) and putting in another row of tuyere holes.

Mr. L. C. Jewett, of the Erie City Iron Works, sent an able discussion, taking the opposite ground to that held by Mr. Webber, and giving the preference to the hot iron more slowly melted every and all the time. Mr. Gus C. Heming described Herbert's cupola, which is considerably used abroad, and which for rapid melting, giving hot iron at the same time, is claimed to be a great improvement. The process is conducted so rapidly, however, that it cannot be used where much mixing of the charge is necessary to make a special metal, as in making car-wheel iron.

STEAM ENGINES AND STEAM JACKETS.

The Secretary then presented Prof. Thurston's paper comparing the real steam engine with the ideal steam engine, which was a really valuable paper, and probably received much less attention from the members than it deserved. Most of Prof. Thurston's former papers, in which he has brought the ideal engine to the notice of the members, have been of such forbidding aspect and so much over the heads of busy men that this paper on the ideal engine from his pen may have been put without much examination in the same category, as there was no discussion. It gives some highly interesting facts, however, and will be abstracted in an early issue of ENGINEERING NEWS.

In the paper following Mr. W. W. Bird described experiments to determine the effect of the steam jacket on a rather peculiar type of compound engine at the Worcester Polytechnic Institute. These showed a gain by jacketing of 11.6%, from which 6% must be subtracted on account of the steam used in the jacket to determine the net gain. Written discussions were presented by Professors Thurston and Alden, and Prof. Denton, who was present, said that the peculiar construction of the engine and the excessive compression probably had much to do with the economy obtained by jacketing.

Prof. W. A. Rogers, of Colby University, then presented two papers, one on the methods adopted in dividing an index wheel into any number of equal parts, and the other on the problem of producing a screw as near perfection as possible. The papers were excellent records of the methods found of value in this especial line of work, and were warmly applauded. As no discussion was offered, the very practical paper on steel castings by Mr. H. L. Gantt was called for. The paper, with discussion, is printed in full elsewhere.

Before adjournment the report of the joint committee appointed by the various engineering societies upon the World's Fair of 1893 made its report. On motion a resolution was adopted approving the project of establishing an engineering headquarters at Chicago during the Exposition for the benefit of members of all engineering societies, but with regard to the proposed International Congress of Engineers to be held in that year, more was desired to be known before expressing approval.

A letter was also read from the Corliss Steam Engine Co., inviting the members of the society who were not their competitors or in the employ of their competitors to visit such parts of the works as are open to the public. No vote of thanks was taken on this invitation.

WEDNESDAY'S EXCURSIONS.

The excursions of Wednesday were to the Wm. A. Harris Corliss Engine Works, the Brown & Sharpe works adjacent, and the Armington & Sims Engine Co. In the evening a reception was given to the society by the citizens of Providence the guests being received by the Governor of Rhode Island, Hon. Herbert W. Ladd.

American Railway Master Mechanics' Association; Annual Convention at Cape May, N. J.

The twenty-fourth annual convention of the American Railway Master Mechanics' Association was called to order by President John Mackenzie at 10 A. M., June 16. The meeting was opened by prayer, followed by a short address by Congressman Raymond, of Pennsylvania. The roll call showed 107 members present, making this the largest convention in the history of the Association. The minutes of the last meeting were accepted as already presented to the members, their reading being dispensed with. This was followed by the President's address, of which the following is an abstract:

At no previous time have the railways been called on to perform such a large volume of business, and at no time have they been compelled to do business with so small remuneration for the work done. The mechanical departments have been called upon to perform the lion's share in reducing the actual cost of transportation. The response has been in renewed efforts to make a ton of coal perform increased duty in the movement of cars. Progress in this direction has gone on steadily. The progress of reducing the cost of transportation of freight has called for constant increase in the weight and capacity of cars in order to make the proportion of dead weight of paying load as low as possible. Locomotives are being made heavier to keep pace with and to reduce the cost of moving cars.

There are two ways in which motive-power officers can decrease the cost of transportation: These are the making of locomotives more economical in the use of fuel, and the reducing of the wages account by making them pull heavier trains.

Fuel is the most expensive item in motive power accounts, and it naturally receives the greatest attention. The efforts to reduce the consumption of fuel have led to decided improvements in the proportions of locomotives. In the past, when little attention was bestowed upon the economical use of fuel, the tendency was to make the cylinders too large for the boiler, with the result that the boiler was intensely forced to generate steam used by the cylinders. This defect is being rapidly corrected. Larger boilers are being applied to over-cylindered locomotives, and a striking feature about all new locomotives is the liberal size of the boilers. The economy that results from the improved proportions is materially reducing the cost of moving trains; and still there is no disposition manifested by the members to rest and be satisfied that nothing better can be done.

The efforts to still improve the motive power is increasing. This progressive sentiment has been manifested during the past year in the introduction by several railway companies of compound locomotives, and the results are highly encouraging. The activity of our members in striving to improve the machinery under their charge may be judged by the work of investigation undertaken during the past year.

The reports to be submitted to you at this Convention

are more varied than any previously presented. Your attention is called to the need of action by this Association on safety appliances for locomotives and cars. You are aware of the fact that committees have been appointed by the Railroad Commissioners and they have had one meeting. They have sent out circulars calling for information under this heading. Two of the important subjects are the "Equipping of Locomotives and Cars with Power Brakes," and the "Automatic Couplers for same." The influence of that committee with Congress will be very great—representing as it does the Railway Commissioners of all the States. In view of this fact, the members of this Association should see that a more than common responsibility will attach to their action while in convention. I sincerely trust that your body will recognize the importance of the situation, and will handle the suggestions seriously and thoughtfully.

Since we met last year the Association has experienced an unprecedented increase of membership, there having been added 95 members during the year.

The death roll has been mercifully light, but the Association has lost one ordinary member and one honorary member. The ordinary was Mr. S. B. Tinker, who joined the Association three years ago; the honorary member was Mr. S. A. Cummings, who was one of the small group of master mechanics that formed this Association 24 years ago.

The report of the secretary showed that the membership of the association was 458, an increase of 95 members, or over 25½% over last year. The income for the year was $2,555, and the expenditures were $2,576. The balance on hand is $1,061.

It was decided that the annual dues should remain the same as for last year, and the following were appointed as a committee to audit the year's accounts: James Boone, W. H. Lewis and H. M. Sprague.

The unfinished business of the last meeting was then taken up. It consisted entirely in the discussion of the proposed amendments to the constitution submitted at that time and published in the annual report of the Association. The amendments were all adopted.

The Secretary was ordered to secure a charter for the Association in the State of New York. A. D. Woods, W. D. Crosman and W. H. Marshall were elected associate members.

The reading of papers and reports of committees was then taken up. The only paper read was by Mr. Chas. Blackwell: "Can steel be worked safely at other than a red heat?" It gave the results of some experiments conducted by the author to determine the point in question, and was in substance that it was unsafe to work steel at a blue heat or at any other point of temperature than that denoted by cherry red. The author exhibited specimens of steel bars bent while cold, twisted at red heat and bent at 600° or blue heat, which went to show the truth of his conclusions.

EXHAUST PIPES, NOZZLES AND STEAM PASSAGES.

Mr. C. F. Thomas then read the report of the committee on exhaust pipes, nozzles and steam passages, published elsewhere in this issue.

The discussion of this report was quite active, and showed a great variety of opinions as to what an exhaust pipe should be. Mr. Stewart considered that the action of exhaust pipes depended largely upon their size as compared with the size of the stack, and thought that the latter should be considerably smaller than the diameter of the former. Mr. Gibbs considered that the action of exhaust pipes could be accounted for on two theories, either a piston action or a jet action; the report seemed to indicate that the latter was the correct theory. Mr. Pomeroy stated that his experiments had led him to the same conclusions as were given the report. The same committee was continued for another year, by which time it was expected that the results of experiments now being made would be available.

ADVANTAGES AND DISADVANTAGES OF PLACING THE FIRE-BOX ABOVE THE FRAMES.

The committee on this subject submitted a report last year which was not conclusive and it was ordered continued for another year. It was unable to give a further report this year and asked that the old report be accepted as it stood. The report was accepted and the committee was discharged.

RELATIVE VALUE OF STEEL AND IRON AXLES.

The committee issued a circular, to which 25 answers were received. Of the roads heard from, 10 were using iron axles exclusively, 6 principally iron, 2 preferred iron, and 4 preferred steel. The answers show a conflict of opinion as to the comparative durability of iron and steel. One case was mentioned where iron axles had run between 200,000 and 300,000 miles without turning, and still callipered true, with a reduction in diameter of $^1/_{32}$ in. Another considered that steel axles gave the greater service between turnings. No comparative mileage of iron and steel axles was given. Mr. T. N. Ely, of the Pennsylvania R. R., stated that formerly steel driving axles had been used by that road for passenger service, and iron for freight service, but this practice had been changed, and now steel axles were being used for the main driving axles in freight service. Many of the breakages were caused by faults in construction. Fractures occurred occasionally in the reduced portion of the axle between the journals, sometimes through the keyway and sometimes nearer the center. Driving axles rarely broke in the journal. The cause of this was that by a fixed limit of wear, instead of a mileage limit, the axles were removed before the danger point was reached. Engine truck axles were made of steel for passenger service, and of hammered scrap iron for freight service, and breaks occurred very rarely in either. Steel car axles were now used for all classes of service. It could not be said that steel had been either better or worse in respect to breakage than iron. There had been cases of axles breaking in the journal. These cases were not common, however, so long as the rules for journal limits were properly observed. A few axles had broken between the wheels in the reduced portion, but this was due mainly to incorrect shape. As now made, the only danger point was the inner end of the journal, and breakages at this point were guarded against by the rules for journal limit.

In conclusion, the committee stated that it was unable to recommend any standards, owing to the limited number of replies received in which any recommendation was made.

PURIFICATION OF FEED WATER.

The committee issued circulars to members of the Association containing the following questions: "Have you had any experience with mechanical devices; if so, with what results? Have you tried chemicals, and with what results? Have you found practical and do you recommend for use any of the mechanical or chemical devices for purifying water?" Answers were received from 88 persons, 31 of whom had no experience whatever in water purification. The reports upon the various mechanical devices were as follows:

The Smith mechanical device was used by nine, who report failure when operated with hard water on account of becoming coated with lime, but when water was muddy and not hard it did fairly well. The device had been discarded in all cases.

The Barnes mechanical device was used by five, who report good results with all classes of water. The device disposes of the heavier solids, keeps crown sheets clean, and reduces greatly accumulations in boiler and water leg, and as a heater and circulator its capacity seems unquestioned.

The Hackney mechanical device was used by five, all of whom found it unsatisfactory. Some report a slight advantage gained with muddy water, but a failure with hard water.

The Fields mechanical device was used by four. Two report failure on account of its becoming choked with lime and its ability to handle only a small percentage of the impurities, and also adversely to feeding water into the boilers above high-water line, which is necessary with this device; and two report the device as decreasing scale accumulations in flues, preventing accumulation of mud on crown sheet, and decreasing number of washings.

The Quackenbush device was used by two, who report some good results with muddy, soft water, but failure with hard water.

The Mattoon mechanical boiler cleaner was used by two. One reports good results with muddy water, foaming being prevented and number of washings decreased; and one reports poor results with alkaline waters.

One each report using the following devices: *Oberchain* device, unsatisfactory; *Rice* heater, failure; a mechanical device from Detroit, Mich., failure; *Shaw's* plan of heating water, recommended; and four other mechanical devices, kind not specified, no beneficial results.

Various chemicals and compounds were used by 29, all of whom report no good results obtained and in many instances harm resulted where test was made in locomotive boilers. Several report good results in stationary boilers, but where good results were obtained the expense of compounds exceeded cost of cleaning boiler and refitting flues. The reports in brief are as follows:

Filtration is recommended by four as the only complete remedy.

Crude oil is recommended by four as preventing scale in stationary boilers and loosening scale in locomotive boilers.

Kerosene is recommended by three, who said it causes locomotive boilers to foam.

Tri-sodium phosphates were used to some extent by three; one of whom reports fair success in loosening scale and two no success worthy of note.

National Boiler Compound was used by two; one reports fair results and one condemns it.

Litofuge was used by three, who could not recommend it.

Sal soda was used by two with pleasing results in preventing scale formation.

One each report using the following methods of purification: Compound of soda ash, caustic soda, lampblack, sorghum molasses, water; used for locomotive boilers according to chemical analysis of water, very beneficial results; compound manufactured at Cleveland, O., benecial results, but too great expense; filtration through boiled potatoes, not able to give results; Hunt's compound, fair results, still experimenting; Lovell's compound, good results, though not fully as represented; Downey's Eucalyptus, condemned; Winan's Incrustation Preventer, nothing gained; magnetic device placed in tank, condemned; and one contemplates placing copper tubes, to which a large percentage of foreign matter will not adhere, as the most economical action.

The proprietors of the Chicago Vegetable Compound have filed testimonials from stationary plant operators who highly recommended it, but no testimony from locomotive men.

From the above the committee concludes that up to the present the efforts to purify the foul water and soften the hard waters, especially for locomotive boilers, have proved unavailing, and there is still much room for experiments in this direction. The sentiment of those who have expressed themselves is in favor of a mechanical device, as against the use of chemicals or compounds. The committee has not the information at hand that would warrant the recommendation of any device, but directs attention to the Barnes mechanical device, which, from a mechanical standpoint and the evidence before it, warrants it in taking this action. The evidence is preponderant and almost unanimous against the use of any chemicals or compounds, while with the use of oils there is ever danger unless the greatest of care is exercised in placing it in boilers, as it cannot be surmised what mischief it is working by adhering to crown sheet or other parts coming in contact with the fire. The committee is skeptical on this point, having personal knowledge of the damage arising from such practices.

Only two members came forward to discuss this report. Mr. Geo. Gibbs, of the Chicago, Milwaukee & St. Paul R. R., thought that the impression that purification of feed water was a failure, which seemed to be conveyed by the report, was wrong. His company had used a compound of caustic soda and soda ash with great success with alkaline water. The cost was about 0.09 cts. per engine mile. He was of the opinion that purifiers could be used with success in some kinds of boilers and with some waters. Mr. J. M. Boon, of the West Shore R. R., regarded both mechanical and chemical purifiers as a failure.

THE PRESENT STATUS OF THE CAR COUPLER QUESTION.

The Committee on this subject, consisting of John Hickey, G. W. Rhodes, Sanford Keeler, R. H. Blackall and M. N. Forney, presented no report, but the Chairman, Mr. John Hickey, of the Milwaukee, Lake Shore & Western R. R., stated that the tenor of the replies received was that the link-and-pin coupler must go. The automatic coupler must have an automatic feature, which none of the present forms did have. There was danger of the coupler pulling out and falling on the truck, and its size was so great that it would ditch the train. The following resolution was then passed:

Be it resolved that it is the sense of this Convention that the vertical plane coupler is a move in the direction of progress, and that the committee be continued with power to represent this Association before the combined Board of Railroad Commissioners.

EXAMINATION OF ENGINEERS AND FIREMEN.

From the replies received by the committee it is concluded that the best practice is not to hire engineers from other roads, but to educate them and promote them from the ranks; where this cannot be done, as on new roads, the same examination should be given as to fireman candidates for promotion. In hiring firemen it is recommended that 28 years should be the age limit, and 25 out of 47 favored having the first year of a fireman's service in a switch engine. At least 3 years' service as fireman should be required before allowing examination for promotion to the position of engineer. If the applicant fails on his first examination he should be given one or even two additional chances, but if he fails in these he should be dropped from the service.

The committee regarded the objections to a fixed set of questions for use in examinations as more apparent than real. If the applicant learns the answers to these questions he acquires much valuable information. Elaborate and intricate questions should not be used. The idea of the examination is not to puzzle or trip the applicant, but to determine if he had sufficient knowledge of his work to satisfy the requirements of service. The committee spoke very favorably of the plan of progressive examinations advanced by Mr. John A. Hill, associate member, and gave a brief synopsis of the method. This consists, in brief, of examining the fireman at the end of each year's service, to ascertain if he is making proper progress.

OPERATING LOCOMOTIVES WITH DIFFERENT CREWS.

To the circular issued by the committee of the Master Mechanics' Association 38 answers were received. Of the roads reporting, 21 stated that they were operating locomotives with double crews, 17 that they did not as a rule and 10 that they double-crewed part of the year. Twenty-nine preferred double-crewing and 6 the pooling or "first, in first out" system. The advantages of the double-crew system were that it decreased expenses for fuel, roundhouse room, etc., and to a great extent fixed the responsibility for lack of crew and accidents. On the other hand, by this system equal hours of rest and labor could not be obtained for the men. The disadvantages of the "first in first out" system were that it did not fix the responsibility for damages, the engines were not properly fired or cleaned. One or two roads expressed satisfaction with the "first in first out" system, but all others said that they used it only because they have not enough power to do otherwise. The committee believe that the system could meet with success only where particular attention

was paid to inspection and repairs. In passenger service it believed the double-crew system was the best, but for freight service it was difficult to arrange runs in regular service, and where many "extras" were run it was nearly impossible. When the "first in first out" system was necessary both results would be obtained by having extra cleaners to clean the engine fairly well while the fire was being cleared and the sand box filled. Oil and supplies should be charged to the *crew* and not to the *engine*, and inspectors should be provided to whom the engine should be turned over on the completion of the run, and who should pass upon its condition and fitness for further service.

LOCOMOTIVES FOR HEAVY FAST FREIGHT AND PASSENGER SERVICE.

The committee took it for granted that the discussion would be entirely on the comparative values of the 10-wheel and mogul types when circumstances made it desirable to increase in power and weight beyond the 8-wheel engine. For the service under discussion the value of the mogul was nearly annulled because the weight of a 19-in. engine over an 18-in. increased out of all proportion to the increased power, unless this power was obtained by decreasing the size of wheel, which was not desirable for the service named. Considering it a fact that weight could be placed on the drivers to utilize all the power, then the question was the most economical use of such power and weight. There had been nothing suggested either by others or by the committee's observation, to indicate that the mogul had any advantage in following the line, either in avoiding destruction of track or itself, although with the actual wheel base the same, the mogul had practically a shorter base, since, with the swinging of pony to one side, the guiding point was carried back under the engine to a point determined by the length of radius bar and angularity of links or hangers.

The committee is satisfied that the rigid truck was perfectly safe, and that in guiding around curves it was exactly right. At the same time, observation of the action of very heavy engines of the ten-wheel class at high rates of speed led it to believe that there was a medium which might be safely followed. While it did not think any swing was needed for curves, yet some benefit would be derived if the truck was allowed to accommodate itself to depressions and bad surface readily. This could be readily done without losing the benefit of the rigid truck, or rather without the defects of swing motion.

A majority were in favor of the ten-wheel engine for the service under consideration. Yet some points of value were given in regard to moguls, even by those preferring the others, especially in lengths of radial bars. But a few gave the rigid-wheel base or entire base, and those who did showed them worked out by the usual formula or very nearly. The general impression appeared to be that where the radius is shortened the guiding action is improved, and a division of flange wear between truck and forward drivers obtained.

The following are the answers given to some of the questions asked by the committee:

Do you consider a ten-wheel engine preferable to the mogul type for heavy fast express train service? If so, why?

Seventeen answered in the affirmative, one in the negative; two had not used ten-wheel engines in such service, but were using moguls, and preferred them for such curvatures as they had; one had ten-wheel, but it was not satisfactory; one used ten-wheel, but had every confidence in the safety of the mogul, and five had no experience.

Do you consider that the pony truck is equally as safe under all circumstances and conditions of track as a 4-wheel truck for fast express engines running at as high a rate of speed as 65 miles an hour?

Two answered in the affimative; 20 in the negative; three no opinion, and two answered in No. 1 as to the use of moguls.

What has been your experience as to flange wear on pony truck wheels of mogul engines as compared with the truck wheels of ten-wheel engines?

Six no difference; five no experience; seven greater in moguls; one greater in moguls with steel tires, no difference with chilled; one less on moguls than eight wheel; two greater on moguls 20%; and 2 to 1 in favor of ten-wheel.

What proportion of weight do you think should be on drivers and pony truck?

These answers ran about a regular scale from four to one or one-fifth on truck, to seven to one or one-eighth on truck with all the intermediates, while three say at least 14,000 lbs. on a pony or 7,000 lbs. per wheel.

What is the limit of weight, in your opinion, one driver should take?

The general answer was 16,000 lbs. for rails under 60 lbs., and 18,000 lbs. for rails above that weight.

What is the least weight you would recommend for a 4-wheel truck?

This was answered by percentages running from 20 to 33⅓, and in direct weights from 7,000 lbs. to 8,000 lbs. per wheel.

On 10-wheel engines would you recommend the blind tire forward or in the center?

Fifteen were in favor of putting blind tire forward; three in the center, and one would flange all wheels.

In case of blind tire being in front, would you recommend a swing-motion truck?

Eighteen recommend rigid truck, one swing-motion, and three very light swing.

The question of economy of operating either a ten-wheel or mogul engine instead of lighter power and more trains was an open one, on which an intelligent opinion could be given only after time enough had been given to observe the expense of maintaining both rolling stock and track, and the committee asked to be excused from offering an opinion on the subject at the present time.

Ten-wheel and mogul engines had been in use for years, yet they had not been used for fast freight or passenger service long enough to afford a great deal of information from actual experience, and many of the answers were given on general principles.

The committee concluded from the information furnished, that the preference was for the 10-wheel engine as against the mogul on account of the forward drivers being simply burden bearers, and leaving wheel basis the same as those of an 8-wheel engine, and because the distribution of weight was such that, while gaining sufficient adhesion to utilize all the power, there was not an excessive weight on either wheel.

In conclusion, the committee considered that the relative economy of these engines in fast service as against 8-wheel could better be answered in the future than at present with the limited actual experience we now have.

STANDARDS OF THE ASSOCIATION.

The committee reporting on this subject recommended very conservative action in adopting standards. It regarded all but a few of the subjects as matters of progress and evolution, and the principle of the survival of the fittest would work out the standard, when experience had developed and determined the best; and thought that only then should they be made standards of the association. It recommended the adoption of a standard of locomotive construction by the different roads, but did not consider it essential that the standard be the same for all roads. In conclusion, the committee suggested that for the present standards should be confined to such subjects as are indicated by the standards already adopted.

AIR BRAKE STANDARDS AND INSPECTION, AND CARE OF THE AIR BRAKE.

The main facts in the report of this committee, which was appointed to confer with and to act jointly with the committee appointed by the Master Car Builders' Association, are given in the report of the proceedings at the annual meeting of that association, published in our issue of last week. This will make the date of the annual meeting the Monday following the second Wednesday in June.

ON BRINGING CONVENTIONS CLOSER TOGETHER.

It will be remembered that at the last meeting a committee was appointed from this Association to confer with a committee from the American Master Car Builders' Association in regard to bringing the dates of the two meetings closer together, in order to make it more convenient to the members who belonged to both associations and who wished to attend both meetings. The committee recommended that the meeting of the American Master Car Builders' Association be held the second Wednesday in June, and that of this Association be held the next Monday after; and that a joint committee be appointed by both associations to decide upon the place of the conventions. The report of the committee was adopted by the Association, and the meetings will be held hereafter according to this arrangement.

DISPOSAL OF BOSTON FUND.

The committee received offers from the Cornell University, the Massachusetts Institute of Technology and Stevens Institute; the first offers scholarships amounting to $5,000, and the last two four scholarships each. It recommended that the offer of the Stevens Institute be accepted; and that the following conditions be necessary to the bestowal of the scholarships: The applicant must be the son of an active or honorary member, or the son of a widow of such a member; application must be made to the Secretary, who will furnish a certificate to the school authorities; applicants must be examined by school authorities under the ordinary rules for admission to the school, and should have at least one year's experience in a machine shop before admission. The report was adopted. The available cash in the fund now amounts to $8,218.

The report was followed by a short descriptive talk on the Baldwin compound locomotive and compound locomotives in general, by Mr. Vauclain, of the Baldwin Locomotive Works. The Baldwin compound locomotive has already been described in ENGINEERING NEWS.

WEDNESDAY'S SESSION.

The convention was called to order at 9 A. M, by the President. Discussion of the report on the Relative Value of Steel and Iron Axles was taken up at once. The discussion showed a considerable variety of opinion. Mr. Wm. C. Swanston, of the C., St. L. & P. R. R., stated that he was using steel exclusively, but considered that it as faster than iron and would break with less use than iron. On the other hand he regarded its life more regular than that of iron. A like opinion was expressed by Mr. Angus Sinclair, who quoted the experience in the use of steel axles on the Manhattan Elevated Rys. in New York. These steel axles were found to have a regular life which could be calculated with considerable certainty. He thought that the quality of steel had a great deal to do with the breaking of axles, and considered Bessemer steel unfit for the purpose. Poor designing also was responsible for many breaks. Mr. J. N. Lauder, of the Old Colony R. R., thought the fault of steel axles was largely in the designing. Steel axles could be designed which were as good as iron, but at present they were not so designed. He thought that lessons could be taken from English practice in this matter. Mr. H. N. Sprague, Superintendent of the Porter Locomotive Works, used steel and found no trouble; the quality of the steel had a great deal to do with failures of axles. Mr. A. Griggs, of the New York & New England R. R., stated that steel axles were used on that road and worked well. They were made of crucible steel. Mr. Geo. Gibbs, of the Chicago, Milwaukee & St. Paul R. R., stated that his company used steel axles to a limited extent, but found them unsatisfactory.

The discussion was followed by the report of the Auditing Committee and the election of J. H. Setchel, W. H. Lewis and John A. Hill as a Committee on Resolutions.

The following honorary members were elected at this session: John F. Divine, E. T. Jeffrey, Jacob Johann, J. Mulligan, Morris Sellers and F. L. Shepard.

ROLL CALL.

The following is a list of the members of the Master Mechanics' Association present, including those responding to the roll call at the opening of the convention yesterday morning:

L. Ames, Beech Creek, Jersey Shore, Pa.; D. L. Barnes, Chicago, Ill.; J. Davis Barnett, Grand Trunk, Stratford, Ont.; J. M. Barr, C., M. & St. P., Milwaukee, Wis.; John Bean, C. & Canton, Canton, Ohio; Chas. Blackwell, Penn. and Dallas Aves., Pittsburgh, Pa.; J. M. Boon, West Shore, Frankford, N. Y.; R. W. Bushnell, B., C. R. & N., Cedar Rapids, Ia.; John Campbell, Lehigh Valley, Delano, Pa.; M. T. Carson, Mobile & Ohio, Jackson, Tenn.; J. J. Casey, L. N. & T., Vicksburg, Miss.; F. D. Casanave, P., Ft. W. & C., Ft. Wayne, Ind.; N. E. Chapman, 251 S. Fourth st., Philadelphia, Pa.; T. L. Chapman; David Clark, Lehigh Valley, Hazleton, Pa.; Isaac W. Clark, C. F. & Y. V., Fayetteville, N. C.; Jno. W. Cloud, Rookery Building, Chicago, Ill.; John S. Cook, Georgia, Augusta, Ga.; C. H. Cory, C. H. & D., Lima, Ohio; A. J. Cromwell, Baltimore & Ohio, Baltimore, Md; G. W. Cushing, Chicago, Ill.; J. F. Divine, W. & Welden, Wilmington, N. C.; Alonzo Dolbear, B. R. & Pittsburgh, Rochester, N. Y.; T. Downing, El., Jol. & Eastern, Joliet, Ill.; W. C. Ennis, N. Y., S. & W., Wortendyke, N. J.; G. T. Ettinger, New York; G. A. Ferguson, Concord & Montreal, Lake Village, N. H.; F. J. Ferry, Louisville, St. Louis & Texas, Henderson, Ky.; M. N. Forney, 145 Broadway, New York; W. A. Foster, Fall Brook Coal Co., Corning, N. Y.; William Fuller, 213 Kennard St., Cleveland, O.; Wm. Garstang, Ches. & Ohio, Richmond, Va.; T. W. Gentrys, Richmond & Danville, Richmond, Va.; George C. Gibbs, M. & St. Paul, Milwaukee, Wis.; Jno. C. Glass, Allegheny Valley, Verona, Pa.; J. B. Glover, Marietta & Nor., Ga., Marietta, Ga.; A. Griggs, New York & New England, Norwood, Mass.; Jno. A. Hill, 96 Fulton St. New York; B. R. Harding, R. G. R. & A., Raleigh, N. C.; E. M. Hedley, Elevated, New York; F. Hedley, Kings Co. Elevated, Brooklyn; John Hickey, Nor. Pac., St. Paul, Minn.; S. Higgins, N. Y. P. & O., Meadville, Pa.; F. Hufsmith, I. & G. N., Palestine, Tex.; E. E. Hudson, C., C., C. & St. Louis, Cleveland, O.; O. H. Jackson, O. & Miss., Vincennes, Ind.; Jacob Johann, 608 Phœnix Building, Chicago, Ill.; I. N. Kulbaugh, B. & O., Pittsburgh, Pa.; J. N. Lauder, Old Colony, Boston, Mass.; F. M. Lawler, C., C., C. & St. Louis, Mattoon, Ill.; H. L. Leach, 1 Rollins st., Boston, Mass.; Pulaski Leeds, L. & Nashville, Louisville, Ky.; William H. Lewis, C. B. & Northern, La Crosse, Wis.; Jacob Losey, Steam Forge Co., Louisville, Ky.; H. A. Luttgens, Rogers Locomotive Works, Paterson, N. J.; John Mackenzie, N. Y., C. & St. Louis, Cleveland, O.; Jas. Magienn, Carolina Central, Laurenburgh, N. C.; Edward May, Intercolonial, Moncton, N. B.; J. S. McCrum, K. C., Ft. S. & G., Kansas City, Mo.; John McKenna, I. D. S., Indianapolis, Ind.; James Meehan, C., N. O. & T. P., Ludlow, Ky.; J. B. Michael, E. T. V. & Ga., Knoxville, Tenn.; Stott Mills, Lehigh & Hudson, Warwick, N. Y.; Thomas Millen, New York City & N., High Bridge, N. Y.; E. A. Miller, N. Y., C. & St. Louis, Conneaut, O.; W. H. Miller, C. H. V. & T., Columbus, O.; H. Monkhouse, C., R. I. & P., Horton, Kan.; J. E. Morrell, C. R. I. & P., Davenport, Ia.; L. C. A. Noble, French Spring Co., Houston, Tex.; J. S. Patterson, Cincinnati, O.; L. B. Paxson, P. & Reading, Reading, Pa.; Peter H. Peck, C. & W. I. Belt, Chicago, Ill.; L. R. Pomeroy, 45 Broadway, New York; Joseph S. Porter, C., S. & C., Sandusky, O.; G. H. Prescott, T. H., I. & St. L., Terre Haute, Ind.; A. W. Quackenbush, Chicago & Alton, Bloomington, Ill.; W. W. Reynolds, C., St. L. & P., Columbus, O.; Geo. B. Ross, Box 326, Buffalo, N. Y.; Wm. Rutherford, J. T. & K. W., Palatka, Fla.; Aug. Schaeffer, Maysville Water-Works, Maysville, Ky.; J. H. Setchel, Cuba, N. Y.; D. O. Shaver, Pennsylvania, Pittsburg, Pa.; Jas. M. Sheer, O. & M., Washington, Ind.; E. T. Silvius, J., S. A. & H. R., St. Augustine, Fla.; W. T. Small, St. Paul, Minn.; Geo. W. Smith, A. T. & S. F., Topeka; William Smith, Boston & Maine, Boston, Mass.; W. T. Smith, Newport News & Miss V., Lexington, Ky.; H. N. Sprague, Porter Locomotive Works, Pittsburg, Pa.; Thomas Shaw, 915 Ridge St., Philadelphia; Angus Sinclair, Morse Building, New York; Jno. Y. Smith, Doylestown, Pa.; W. A. Smith, 25 Elizabeth St., Worcester, Mass.; O. Stewart, Fitchburg, Charleston, Mass.; F. A. Stinard, 8 Dickinson St., Paterson, N. J., Henry K. Stout, Penn., Sunbury, Pa.; William C. Swanston, St. L. & P., Indianapolis, Ind.; H. Tandy, Brooks Locomotive Works, Dunkirk, N. Y.; C. F. Thomas, Richmond & Danville, Alexandria, Va.; W. H. Thomas, E. T. Va. & Ga., Knoxville, Tenn; W. A. Walden, Richmond & Danville, Atlanta, Ga.; Beriah Warren, T. P. & W., Peoria, Ill.; Amos H. Watts, C., J. & M., Marshall, Mich.; E. L. Weisgerber, Baltimore & Ohio, Newark, O.; Reuben Wells, Rogers Locomotive Works, Paterson, N. J.; A. M. White, Schenectady Locomotive Works, Schenectady, N. Y.; D. A. Whitman, Pittsburgh Locomotive Works, Allegheny, Pa.; E. A. Williams, M., St. P. & St. S. M., Minneapolis, Minn.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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GEO. H. FROST..... .....BUSINESS MANAGER

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Advertising rates, 20 cents per line *agate measure. Schedule sent on request.* **Changes** *of advertisements must be in hand on Tuesday afternoon:* **New** *advertisements Wednesday afternoon;* **Transient** *advertisements not later than Thursday noon. The last pages go to press early on Friday, and we shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.*

Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty, or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*

COMING TECHNICAL MEETINGS.

Engineers' Club of Philadelphia.—June 20. Secy., Howard Murphy, 1122 Girard St.

Western Society of Engineers.—July 1. Secy., J. W. Weston, 230 La Salle St., Chicago.

Engineers' Club of St. Louis.—July 1. Secy., Arthur Thatcher, Room 801, Odd Fellows' Building.

Engineers' Club of Minneapolis.—July 2. Rooms, Public Library Bldg. Secy., F. W. Cappelen.

Association of Civil Engineers of Dallas.—July 3. Secy., E. K. Smoot, 803 Commerce St.

Technical Society of the Pacific Coast.—July 4. Secy., O. von Geldern, 319 Market St., San Francisco

Civil Engineers' Society of St. Paul.—July 6. Secy., C. L. Annan.

Civil Engineers' Association of Kansas.—July 8. Secy. J. C. Herring, Wichita, Kan.

Engineering Association of the South.—July 9. Secy., Otis B. Lanoreth, Vanderbilt University, Nashville, Tenn.

Engineers' Club of Kansas City.—July 13. Rooms, Baird Building. Secy., H. Goldmark.

Atlanta Society of Civil Engineers.—July 14. Secy., Parker N. Black, 39 Capitol Block.

Civil Engineers' Club of Cleveland.—July 14. Secy., A. H. Porter, 50 Euclid Ave.

Boston Society of Civil Engineers.—July 15. Secy., S. E. Tinkham.

Engineers' Club of Cincinnati.—July 16. Secy., J. F. Wilson.

Engineers' Society of Western Pennsylvania.—July 21. Secy., J. H. Harlow, Pittsburg, Pa.

Denver Society of Civil Engineers.—July 23. "Canals and Irrigation." Secy., Geo H. Angell.

THE Master Car Builders' Association is to be congratulated upon the work done at the annual convention held last week at Cape May. Some desirable reforms were not fully appreciated and were defeated, as generally happens, but on the whole a substantial majority was in favor of progress and was able to carry a number of important measures. The most important action was probably the adoption of rules for the interchange of air-brake freight cars, under which freight air-brakes will stand a better show of receiving proper oiling and adjusting when off the line of the home road than they have had heretofore. The matter of standards for the M. C. B. coupler was brought up so near the close of the convention that there was not time for as much discussion as was desirable. Perhaps the action taken (recommending for trial the gages and templets reported by the committee for determining standard contour and dimensions, and referring further questions connected with coupler standards to a new committee) was all the Association was really prepared to do at present. Large bodies move slowly, but by another year the question of limiting the number of M. C. B. couplers is pretty sure to come up. The case in a nutshell is simply this: It is unjust to expect that for every new coupler put into use on a few hundred cars a stock of extra knuckles to fit this particular type shall be purchased for every important interchange point and every repair shop. It is altogether probable that some of the new inventions in M. C. B. couplers will have but a short life; and when they go out of business there will be more or less of the knuckles in the hands of railway companies which will have to go to the scrap heap. On the other hand, we do not wish to shut the door to possible improvements in the M. C. B. coupler. Nor can we run the risk of a combination to raise prices by limiting the number of manufacturers to four or five. The only way between the horns of this dilemma which we have yet heard of is to amend the rules of interchange by providing that a car fitted with a make of M. C. B. coupler of which less than a certain number of thousand are in use, may be refused in interchange unless a spare knuckle is securely attached to some designated part, or in its absence a card is put on by the road removing the knuckle to replace a broken one, acknowledging responsibility for the breakage. In this way the keeping in stock of more than a half dozen kinds of knuckles at interchange and repair points would be avoided. Of course, some means would have to be devised for securely fastening the knuckle to the car, so that it would not be likely to be stolen. The liability that the knuckle would be stolen seems, indeed, the chief objection to the plan. On the other hand, however, a cast-steel knuckle is neither very easy to carry off nor very valuable as scrap, and it would be difficult for a thief to dispose of many without insuring his own detection. From every point of view the move appears to be a good one for the railway companies, and the new companies which are trying to enter the field as makers of the M. C. B. coupler cannot complain. They may well make some concessions to pay for the trouble to which they put the railways by the added diversity which they introduce, and for the privilege of establishing themselves in a profitable business.

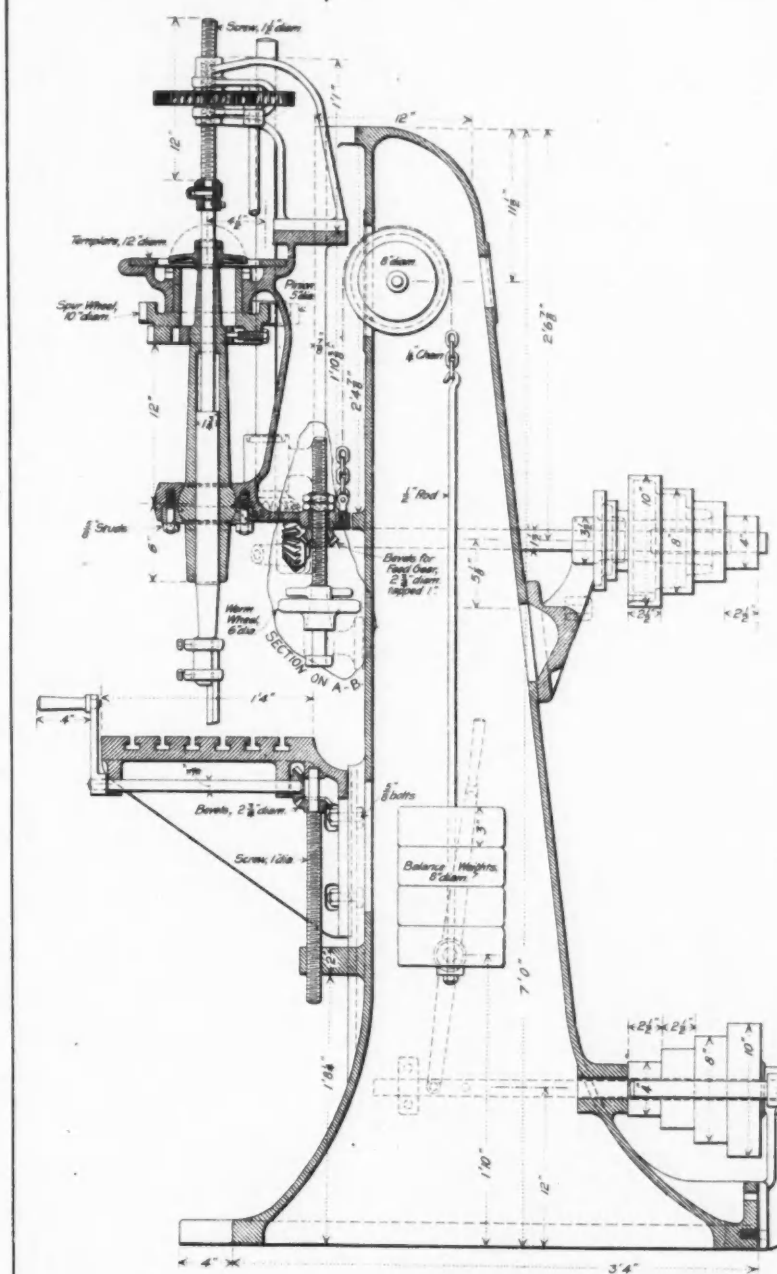
BESIDES the brake and coupler questions, which every one now concedes to be those of greatest importance, the action of the Association in definitely adopting a permanent arrangement by which the annual meetings will be held at the same place as the Master Mechanics' Association, and only five days in advance, was a step worthy of special note. The system of joint car inspection, which is to be submitted to letter ballot, and the innovation by which car owners are to be responsible for a greater amount of repairs made necessary by ordinary wear than hitherto, are the other changes of importance. The innovation by which the reports of the committees are placed in the hands of members a week in advance of the convention met with universal favor: if it is important in the case of the engineering societies to have the papers distributed in advance, it is far more important here, where the measures reported by the committees may necessitate the expenditure of millions of dollars by the railway companies. The Master Mechanics' Association has also printed its reports this year and sent them out in advance for the first time; and the change should result in a perceptible improvement in the proceedings of their meetings, as it has in the engineering societies.

THE last of the summer conventions of engineering societies was the meeting at Providence during the past week of the American Society of Mechanical Engineers, the report of which, with several of the papers, we print in this issue. Among the papers presented at this meeting are some of the best which have been before the Society for some time. It will hardly be disputed that the two papers of greatest interest and importance are those by Messrs. GANTT and HOWE on "Steel Castings" and "Manganese Steel," both of which we reprint in full this week. The former paper is of a class too infrequent in the transactions of every technical society. The simple, practical information which it gives is just what every engineer needs or may need to know. Mr. HOWE'S paper is a well written one on a material which is little known by engineers in general; but is destined to be better known unless all signs fail. Mr. HOWE kindly warned his readers that, as he has a pecuniary interest in manganese steel, they must make allowance for some bias on his part; but there are few men who can speak with much authority on any new thing in engineering unless they have had enough pecuniary interest to lead them to get at the bottom facts. A careful examination of the papers presented at this meeting will show that nearly all those of much importance were prepared by men having both a practical knowledge of and a pecuniary interest in the matters described.

Not only in the importance of some of the papers, but in the large attendance, is the Providence convention a notable one. Nearly 350 members signified their intention to be present to the Secretary and the attendance on the opening day exceeded 200. This is quite remarkable in view of the fact that the location is so far distant from the "center of gravity" of the membership. The attendance certainly exceeds that at any previous meeting of the society and is claimed to be even greater than at any convention of any of the engineering societies. The growth in membership of the society in the past year has been 141, making a total of 1,268 members at the present time. This is a most gratifying increase; but it is to be remembered that the society has probably a larger field from which to gain members than any of the other engineering societies.

INTEROCEANIC canal matters in Central America are interesting the public just now, and from several standpoints. The prominence of the Nicaraguan project is evidently stirring up jealous opposition, and one Philadelphia paper, the *Record*, editorially attempts to prove that the United States Government should officially investigate the Panama scheme before committing itself to its rival in Nicaragua. This editorial bristles with misinformation that could only come from a pen most unfriendly to the latter enterprise. It is false in its estimates of cost, magnifying those for Nicaragua as much as it minimizes the Panama figures; ascribes even worse climatic conditions to Nicaragua than to Panama, and lastly assumes that all the required surveys are made at Panama, and that all the plant is on the ground to continue work at once. It might require a careful United States survey to convince some Frenchmen that the Isthmus scheme was dead beyond resurrection, and as worthless as most of the plant referred to, but we hardly think it is necessary.

Then, from Paris, we hear that the army of deluded shareholders is at last taking steps to bring the promoters of the Panama Canal to an accounting. The Count DE LESSEPS and his son CHARLES DE LESSEPS, together with the other active Paris agents in the scheme, are to answer charges of



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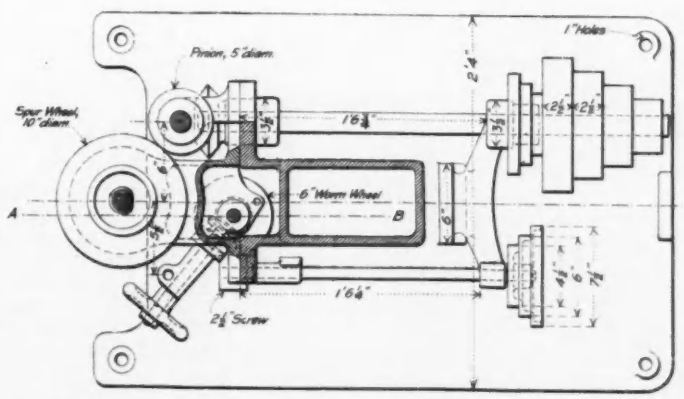

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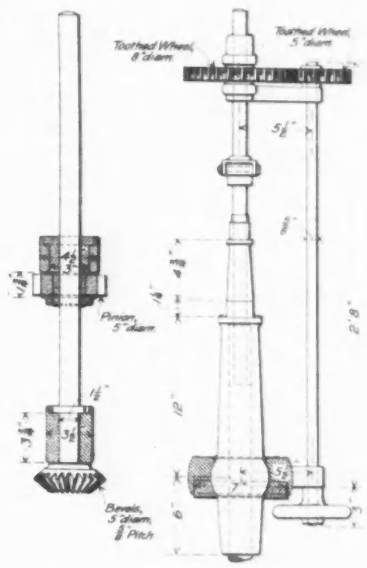

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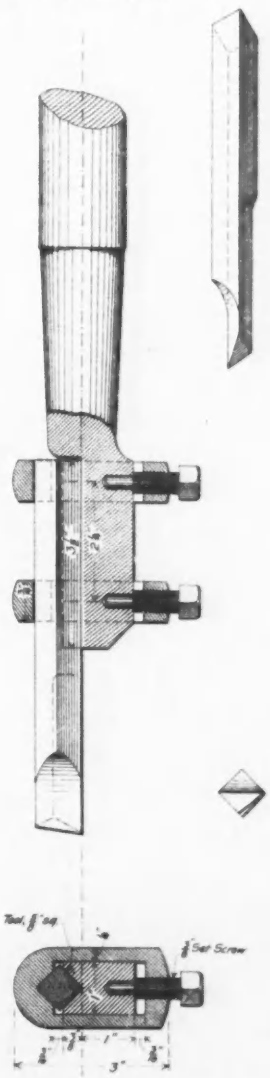

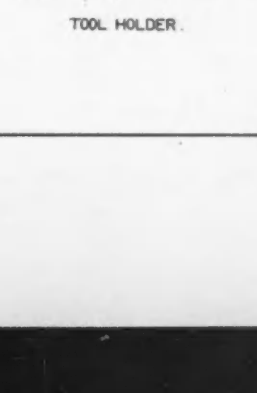

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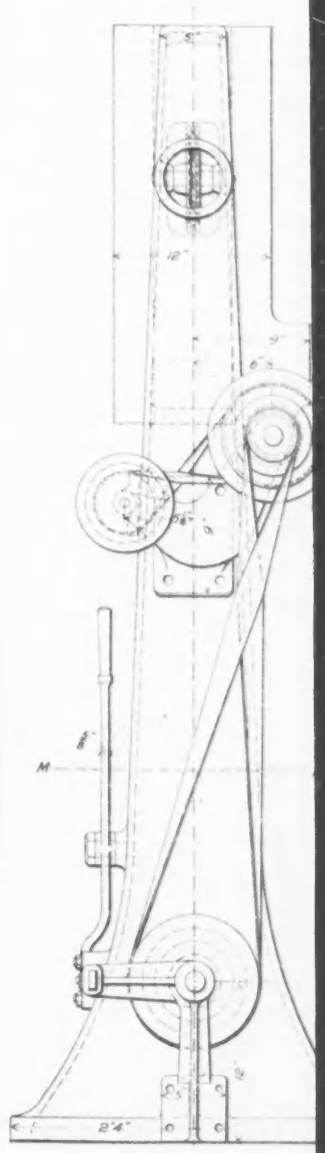

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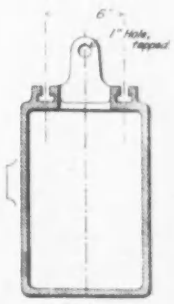

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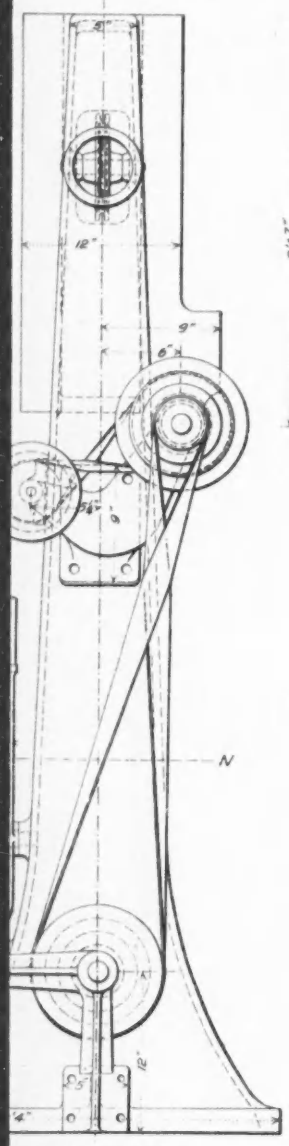
SQUARE HOL

AINLEY-OAKE



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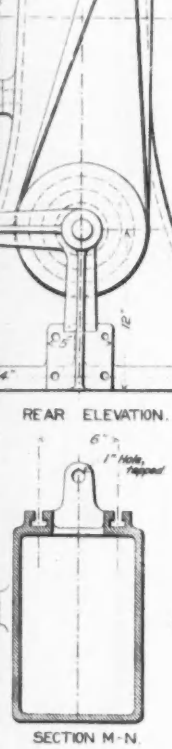

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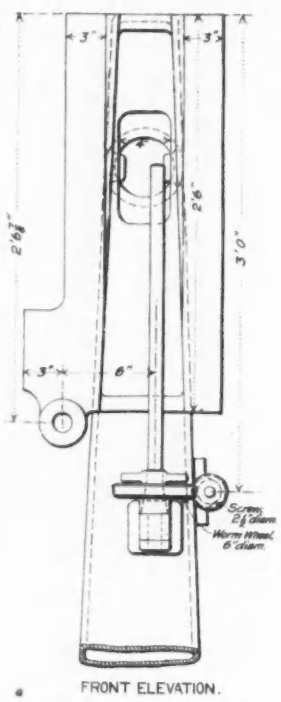

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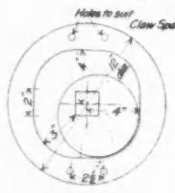

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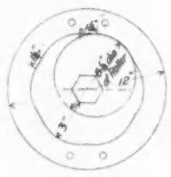

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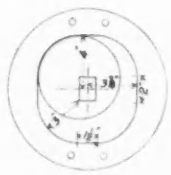

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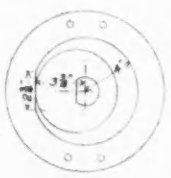
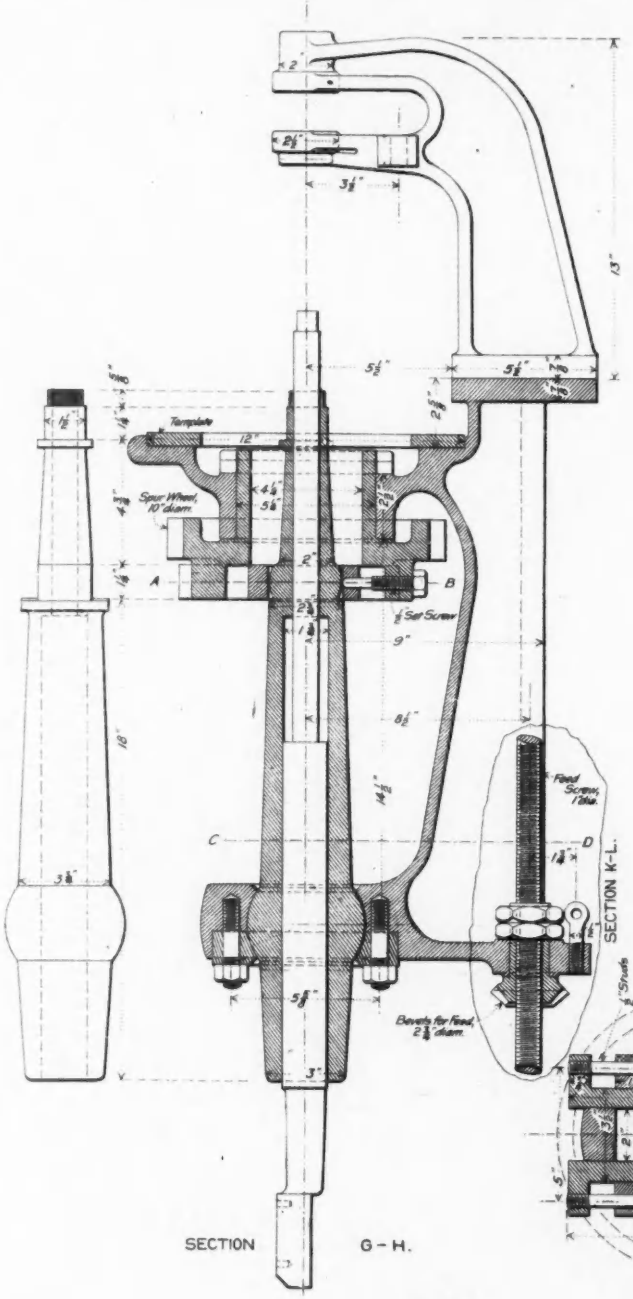


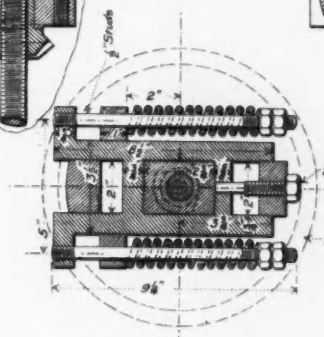
SEGMENT.

TEMPLATES.



SECTION G-H.

SECTION K-L.



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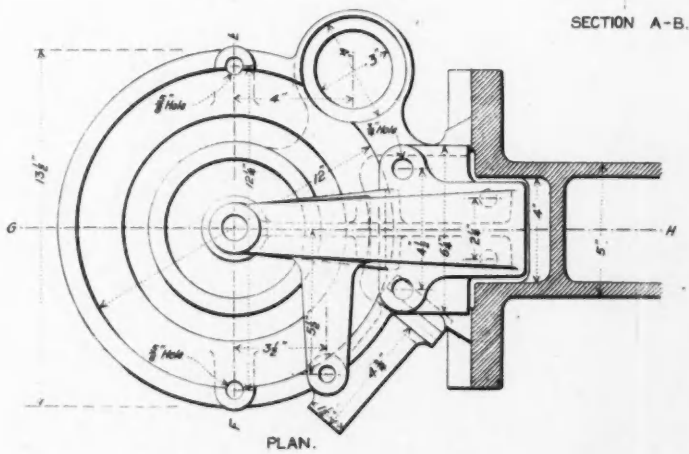
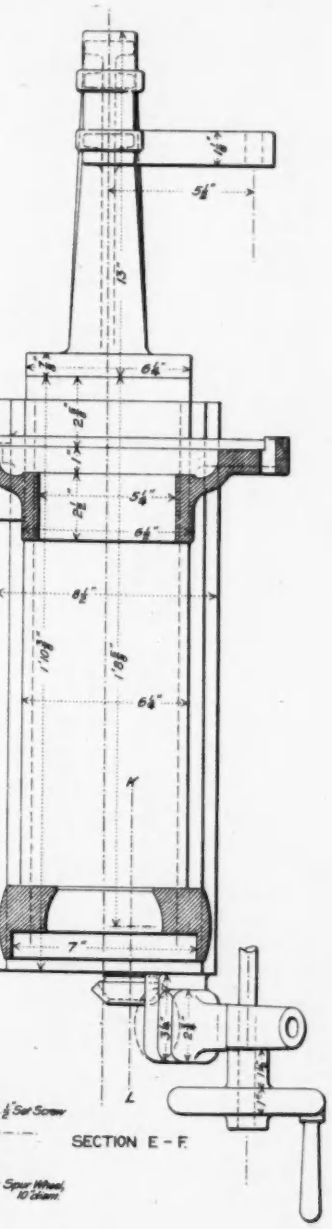


PLAN.

Square Hole Drilling Machine.

Ainley-Oakes Square Drill Syndicate, Ltd.



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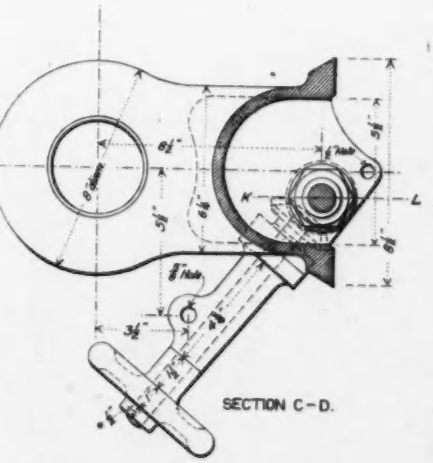


SECTION C - D.

CHAS. HART & SONS, LITH., 54 VESEY ST., N.Y.

false representation of conditions and progress, whereby men were induced to invest in an enterprise that the promoters knew to be unsound. other charges are to follow of extravagant and reckless management and corruption in the purchase of material and execution of the contracts. One well authenticated Paris report has it that CHARLES DE LESSEPS now takes rank among the wealthiest men of France, thanks solely to the adroit manipulation of Panama shares on the Paris Bourse. By his intimate connection with the company's affairs he and his associates were enabled to safely gamble upon the information thus obtained. The elder DE LESSEPS is now an old, and, it is said, a physically broken man, and he will doubtless have the sympathy of many who, like ourselves, believe that he was led originally into the Panama Canal scheme by grossly insufficient plans and estimates, and by his own confidence in the personal reputation gained at Suez. He is not an engineer, and could have been thus deceived, and was not likely to detect the weak spots in the engineering detail or the lack of complete surveys. But on the other hand, he was not a fool, and it will be hard for him to explain why he clung to an enterprise that he could not help seeing was being wastefully and fraudulently managed, and why he persistently made statements and promises that he knew could not be met or filled. It was his personal reputation as the builder of the most successful ship-canal in the world that induced the most of his countrymen to subscribe at all; and he cannot now shirk the responsibility that this reputation entails.

The Steam-Pipe Explosion on the Concord.

The recent explosion of the main steam pipe of the United States gunboat *Concord* will probably lead to a more careful examination by naval architects and mechanical engineers of the copper steam pipes which precedent prescribes for use in marine steam engineering. Two serious steam-pipe explosions in England within a year or so have set our British cousins on their guard; and this occurrence, with the thorough investigation which is promised, will probably lead to a similar result here. It is impossible to decide from the press reports whether the longitudinal tear, 20 ins. in length, which was made in the steam pipe, was along the seam where the sheet was brazed together in making the pipe or was due to a defect in the solid sheet. The latter seems to be indicated by the fact that at the center of the break there was found a tap hole, where a defect had apparently been remedied (?) by reaming out the hole and screwing in a plug. Surely no man in his senses would venture to cure a defective spot in a brazed seam by boring it out and screwing in a plug. It is quite conceivable, however, that an apparently slight defect in a solid sheet might be bored out and remedied in this way with some degree of safety, although it would hardly rank as first-class work.

But whether the *Concord* explosion proves to have been due to careless or defective construction or not, it is to be hoped that it may serve to impress on American engineers the danger inseparable from the use of the common copper steam pipes with brazed seams. Their inherent defect is that their strength depends entirely on the workmanship of the brazed seam; and it is not possible to certainly know whether that workmanship is good or bad. Brazing together the edges of a copper sheet ¼ in. or more in thickness and often many feet in length requires skillful workmanship to produce a good job; and even a little carelessness at any point may greatly lessen the strength of the pipe. Careful inspection of the seam and subjection of the pipe to a hydraulic test will generally detect a defect if it exists; but they are not infallible evidence, for the defect may be hidden in the interior, and may withstand the hydraulic test when the pipe is new, and then fail at a much lower pressure months afterward, having been weakened by the vibration of ship, engines and guns.

It is not in accordance with modern engineering practice to risk so much on the strength of a link whose strength cannot be certainly known. Surely it ought to be possible to make steam pipes with a known strength which should make them absolutely safe against explosions. It is yet to be proved that the use of the common brazed copper steam-pipe is a necessity. In our issue of Nov. 23, 1889, reference was made to the possible use of steel or iron pipes for steam pipes in marine service, protecting them from corrosion, if necessary, by a lining or plating. It is needless to remark that the material in a steel or iron pipe of double the safe-working strength of the copper pipe would cost but a small fraction of the sum necessary for the copper pipe.

The manager of a Philadelphia shipyard, turning out the highest class of work, recently stated to the writer that the only reason for the use of copper pipes is the contracted space in which the pipe fitting has to be done, making necessary the use of sharp bends and turns which could not be made with iron pipe. The modern tendency in all classes of marine steam machinery is to crowd it into the smallest possible space, and the numerous pipes must be got in wherever room can be spared.

Unquestionably this makes the use of iron or steel pipes on shipboard a difficult matter; at the same time it is to be remembered that mild steel is a material with which remarkable things can be done. The spiral welded pipe and the seamless pipe rolled from the solid bar by the Mannesmann process both avoid the longitudinal welded seam of the common iron pipe. The Mannesmann tubes especially are of such great strength and ductility that they will endure a considerable amount of bending without injury, as was shown by the specimens exhibited at the International meeting of metallurgical engineers at Pittsburg last October. For bends too sharp to be made even with the Mannesman pipe it is possible that the use of cast-steel elbows of the desired angle may help us out. The electric welding process or the use of better forms of pipe coupling may overcome the objections to the use of a pipe with many joints.

Even if experiments with mild steel prove that we must still stick to the expensive copper pipe, it does not follow that we must depend on the strength of a brazed seam for safety. The Elmore copper depositing process, which has been fully described in these columns, turns out copper tubes of any desired size with a strength equal to that of mild steel, and, what is of much more importance, absolutely without a seam or a possible defect of workmanship at any point. It is true that the reputation of the process has been somewhat injured by rumors of stock-jobbing operations by its managers; but the testimony of engineers who have examined the process and tested its product leaves little room for doubt that, whatever the financial character of the Elmore Co., the process itself is of much practical importance.

Again, there are possibilities of increasing both safety and economy by combining the ordinary copper pipe with an envelope of stronger and more reliable metal, in which case the weight and cost of the copper pipe might be very greatly reduced. Shrinking tubes or hoops over the copper pipe would hardly be practicable, on account of the numerous bends required; but the copper tube might be wound with steel wire until its strength to resist the internal steam pressure would be beyond question. The difference in expansion of the two metals when heated would tend to transfer a large proportion of the strain to the wire envelope when steam was turned on, even if the wire were not wound very tightly.

But of all the systems suggested for removing the dangers attendant upon brazed copper pipes, the simplest, and apparently one of the most promising, is that invented by Mr. S. Z. DE FERRANTI, of London, whose mammoth dynamos and high-pressure electric mains are among the greatest achievements of electrical engineering. In this system, in place of a single steam pipe, say 8 ins. in diameter, there are substituted a number of small steam pipes, say 22, each of 2 ins. diameter, giving an aggregate cross-section enough greater than that of the larger pipe to compensate for the greater friction of the steam when flowing through the smaller pipes at the same velocity. These small pipes can be bent much more easily than can the large pipes, and while theoretically they take up more space, practically the sharper bends, and the fact that the pipes can be placed in a flat bundle if desired instead of in a circular form, seem likely to make them fully as convenient as the single pipe. Moreover, with the use of small pipes of this class, steel or iron could be substituted for copper with a great saving in expense as well as a great increase in strength and safety. Another advantage would be the doing away with all joints in the pipe, since, except for very long runs, pipes of the full length needed could be had.

These are what seem to be the most promising directions for experimenting, if we are to prevent such accidents as that on board the *Concord*. That such accidents are preventable, the achievements of modern engineering in the solution of problems vastly more difficult leave little doubt.

The Underground Rapid Transit Route.

As remarked in a late issue, the New York Rapid Transit Commission, in its recommendations for a west-side four-track electric rapid-transit route, has well stated the requirements for a line of this character, and has settled upon the type and location of the route after a very sensible fashion. Briefly recited, the essential features of such a route are: That it be susceptible of additions without radical change from the original construction; that it provides for both express and local traffic, on separate tracks, but with facilities for exchange; that the street surface be obstructed during construction to the least possible extent, and that private and not public property should be used at the surface; and finally, that the first lines built should be on or near the main arteries of travel.

Acting upon these lines, they recommend, for a general plan, a double-decked tunnel, or a tunnel with four tracks side by side, extending from South Ferry to 42d St. under the line of Broadway. This tunnel is to be placed so deep as not to disturb the surface or to endanger building foundations.. Above 42d St. the route suggested follows Broadway to 59th St., then along the Boulevard to a point near 169th St., with a viaduct of proper design near Manhattan St., thence under Eleventh Ave., or private property, if more desirable, to a viaduct over Spuyten Duyvil Creek, and by tunnel or viaduct to the city limits. The plan proposed above 42d St. is a four-track road placed as near the surface as possible, but not in an open cut, the four tracks to be parallel to each other. For all lifts of 20 ft. or more below the curb line ample elevator capacity is to be provided, and the motive power is to be electricity or other power not requiring the combustion of fuel in the tunnel.

This plan at once removes the most serious objections to older plans along practically the same route. These were the almost prohibitory cost of right of way through the blocks for an elevated system, and the valid objections of property owners along Broadway that the near-surface tunnel projects would endanger their buildings if an

attempt were made to carry them out. In this statement it is assumed that the city authorities will not grant permission to a further extension in track-space over the streets of New York to the existing elevated system.

According to some, and, we fear, interested, authorities this latter solution of the problem would be the simplest of all, as it would only require the extension of a system already well tried and in active operation. But as four parallel tracks are in many places impossible without the condemnation and purchase of property on both sides of the street, and as a double-decked structure would also inevitably result in equal damage to property interests, the cost of the proposed change would practically prohibit its execution. This plan would also violate the first rule laid down by the Commission for its own guidance, and that is that any permanent system adopted should be susceptible of additions without radical change of plan. No one can foretell the needs of New York for rapid transit a decade or two from now, and the capital and interests involved call for a character of construction that will last for generations. Extension of facilities will doubtless be required in the future; but who would wish to see elevated structures of any type threading up and down and across Manhattan Island, encroaching upon surface property already of almost fabulous value? Our streets are now needed for other purposes, and future New York would certainly have to find other routes for rapid transit. Hence it would be folly to extend, at great cost, a system which cannot itself be further extended, and the Commission, in recognizing this at the start, has acted wisely.

As to the plan proposed, it requires in the fulfillment of its terms, a deep underground tunnel under Broadway as far as 42d St. At least, this would now seem to be the most economical and the safest plan of constructing a tunnel which will not "disturb the surface or endanger building foundations." The borings made by Mr. CHARLES M. JACOBS, C. E., the engineer for Mr. CORBIN in his scheme for a deep tunnel, show about the following conditions under Broadway: At Whitehall St. rock is found 43 ft. below the street level; at the Equitable Insurance Building, 60 ft.; at the Mutual Insurance Building, 56 ft.; at Cortlandt St., 65 ft.; above this street, excepting only the dip at Canal St., the rock seems to run at about this same level of 60 to 65 ft. until 12th St. is reached, where the rock rises toward the surface up to 14th St., and above this point to 155th St. its average depth below the curb is 23 ft., with frequent outcrops at the surface, as at 33d St.

As it is below 12th St. that the most danger is to be feared to structures, the depth of tunnel adopted for lower Broadway would be practically the ruling depth, with an ascending grade to 42d St. Assuming 65 ft. as the average depth, and even then a sufficient allowance may not be made for undulations and fissures in the rock, a roof of at least 20 ft. must be added to this depth. When the height of a double track tunnel is further added we find the rail level is very nearly the 100-ft. mark proposed by the advocates of the deep-tunnel system.

Even with the application of the Greathead, or a similar method of tunneling, the earth above the rock is hardly deep enough to insure any safety to the surface or to adjacent foundations. Many of these foundations would extend almost if not quite to the line of the tunnel roof; and the nature of the soil is not especially calculated to encourage an engineer to take the chances of tunneling through it, with a New York office-building, for example, too nearly overhead.

We have seen some of the diamond drill cores removed by Mr. JACOBS, and they show, by their unbroken length especially, a solid gneiss rock, well adapted for economical excavation with modern tunneling appliances. With an approximately good roof overhead a rock tunnel is immeasurably cheaper and safer than a surface tunnel, so to speak. And though large quantities of water are not indicated by the borings made, proper pumping plant would readily clear a tunnel which can be located on a slightly ascending grade for its whole length. The theory of some engineers that a heavy volume of water underlies this rock is hardly borne out by the fact that at the Fifth Avenue Hotel a boring was made for water 2,110 ft. deep, through rock for the whole distance. The disposal of the refuse from the tunnel excavation would be expensive, but the same objection applies to the earth from a tunnel nearer the surface, and of the two materials the rock would probably have the greatest market value for filling purposes. The Jersey City flats, about Communipaw, for example, would dispose of more material than the tunnel could produce.

With a secondary motive power, or one not consuming fuel in the tunnel, with electric lights and ample elevator service, the terrors of an underground railway are substantially removed. With deep and wide elevator shafts at short intervals and electric or other "clean" motors used, the ventilation of a deep tunnel should not be a difficult problem. The present trouble in this respect at the Fourth Avenue tunnel in this city is directly due to the following two facts: that engines emitting steam and smoke are in constant use within them, and they are so close to the surface that they are readily affected by atmospheric changes. Neither of these objections would apply to a tunnel 100 ft. below the surface, and operated by some other motor than locomotives. The preference for daylight transit is more sentimental than otherwise if the cars are properly lighted. The demands for a return from the property confiscated would make any feasible elevated or viaduct system run practically in a tunnel except over the streets. And of all means of travel a line of short tunnels, that compels the traveler to constantly alternate between daylight and lamplight, is the most annoying. A trip over the railway skirting the Mediterranean coast from Nice is a trying example of this system of road, where there are in places 10 short tunnels to the mile. This is almost equivalent in frequency to the distance between city blocks.

Very high viaducts are possible, and the city of Naples is now building one to connect the high ground back of that city with its business center, that will have piers 100 meters, or 328 ft., high. But a lofty viaduct of masonry, while it would perhaps be the ideal roadway for rapid transit, is likely to remain an ideal structure in New York. Its cost for real estate and construction would be too enormous even to consider, and its operation would demand elevators and all the handling facilities applicable to a deep tunnel. The objection to a lofty framed viaduct of steel or iron is best appreciated by those who have to pass over existing structures of that kind on our up-town elevated system. This viaduct would be expensive, as the spans would necessarily spring from about the centers of blocks and be long to compensate for the tower or pier cost; it would be in constant need of attention, painting etc.; and in case of a large fire beneath it all traffic would be stopped and one or more trusses would be possibly injured beyond repair.

In fact, a tunnel through rock is about the only structure for this purpose that can be called permanent; and permanence, safety and convenience are now demanded. In the line of future extensions, branches, etc., the tunnel plan is one admitting these with the greatest ease and after one general type of construction. In the rock beneath New York right of way is practically valueless, and choice of route is not bounded by surface lines or occupation. Branch tunnels can be run to main ferries and railway stations when the traffic demands it, and tunnel lines can cross over or under other tunnel lines in a manner that would be exceedingly costly above the surface. In one sense the rock area beneath the city is as free as the air above our heads for location purposes, but with the essential difference that the freedom to use this rock carries with it a substantial foundation for the structure, while for structures in the air this foundation must be secured in addition, and at surface prices—not bedrock figures.

As to the cost of the tunnel, no man can now do more than estimate this upon the data furnished by the borings and general tunnel experience. But this estimate would be, undoubtedly, a safer and closer estimate than one based upon the best attainable data for a tunnel near the surface on Broadway, or even for an elevated structure in which damage to property adjacent could only be settled after long litigation. As real estate for a through-the-block viaduct has been variously estimated as costing from $50,000,000 to $75,000,000, it is safe to say that a very extensive underground system could be built entire for the mere cost of the right to build in the other case. Of course it is figured that the real estate would yield a rental that would bring the enterprise within safe commercial lines. But to obtain this rental at all a vast amount of cash must be first expended, and interest paid thereon, to make the land available for this purpose. And it might take time to teach people that property under a railway track was just as desirable as any other for general business purposes. Any system of rapid transit for New York will require a heavy outlay of money; but the tunnel scheme promises to cost the least of all feasible methods. As to prospective traffic, and hence returns, the fact that the increase of travel on the present elevated system was 71,000,000 passengers in the four years between 1886 and 1890 speaks loudly enough. Every route is now crowded, and that the extension of facilities increases travel is a law of traffic well established.

The plan suggested by the Commission for the up-town line is based upon very different conditions from those existing lower down, and here again their conclusion is a wise one. Above 42d St. there is rock very close to or on the surface. The streets are wider; the high and important buildings less frequent, and these being founded upon rock, are not liable to injury by nearness of other structures. Here a substantial tunnel could be built so close to the street surface as to include within its area the many secondary viaducts, lines of pipe, etc., that now necessitate ripping up this surface; and, as a consequence, the street paving could be maintained in proper condition at a minimum cost. It is true that the disposal of these other lines of pipes, etc., in the rapid transit tunnel, is one of the strong arguments used in favor of a tunnel near the surface in Broadway. But while this is well enough as far as it goes, this plan for doing something else besides providing for rapid transit, may cost too much. It is very proper to unite these purposes when other conditions are equal; but in Broadway while we badly want a subway system for these smaller pipes, this subway can be built cheaper independently if it is located just beneath the street surface, where it belongs and can be best used.

CORRESPONDENCE.

Wooden Water Mains.

BRIDGEPORT, CONN., June 13, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR:—In the columns of your valuable paper of this date I find an article from A. McL. HAWKS on wooden water mains. Mr. HAWKS refers to a wooden main at the water-works at Manchester, N. H., put in use in 1874. It is mentioned as something entirely new. This is a great mistake, as about 40 years ago I constructed the first one I

ever saw. It was constructed in 12-ft. lengths of 2-in. pine plank, made tapering, so that one end fitted into the other after the manner of a stovepipe. The bands were made solid, of different diameters, about ¼ in. thick and 2 ins. wide.

This plan of constructing wooden conduits was continued for many years, and many of them were constructed. It was, however, a difficult job always to make them tight at the connections, and in order to overcome the difficulty I commenced, some 10 years later, to make the staves break joints, using plain iron bands ⅜ x 2 ins., having both ends welded on, and passing through a cast-iron piece, with nuts to draw up the staves tight together. This plan I have in my practice abandoned, and now have my bands made solid and of exact uniform size, or inside diameter, and uniform in width, so that they may be made continuous breaking joints. I have all the joints come under the bands, and use small jackscrews to bring the staves to a good tight joint, and put in what is called a closer, a stave fitted to fill the space driven in at the end of each stave. A dowel is put in of iron 1¼ ins. wide and 1-16 in. in thickness. The number of bands is governed by the pressure to be sustained. The durability of a conduit when laid above the ground, with air all around said conduit, is from 40 to 50 years; when partially exposed or covered, from 10 to 15 years; when buried under ground, with air excluded, an indefinite length of time. I have contracted for pipe from 10 to 8½ ft. in diameter, using 2-and 3-in. plank. Saddles are prepared for the conduit, 6 ft. on centers. The cost is generally about one-third that of iron, and these conduits are mostly used for mill purposes. I have put in a large number of feet during the last 10 years. B. H. HULL.

We are pleased to give space to the above contribution, as it contains many interesting points regarding the earlier use of wooden conduits in this country. Mr. HAWKS cited the Manchester conduit as "one of the earlier examples" and "one of the best known," and not as "something entirely new," as Mr. HULL states above.—ED. ENG. NEWS.]

Floating Equipment of Great Lakes.

SHARPSVILLE, Mercer Co., Pa., June 15, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: The Census Bulletin No. 29, on "Floating Equipment of the Great Lakes since 1886" is extremely misleading, to say the least, and is very far from being what it pretends to be: An accurate showing of "the changes in the conditions of transportation on the great lakes" that have taken place since 1886. The radical error in the *plan* of the Bulletin is the scheme for omitting entirely all vessels arbitrarily classed (by the Bureau) as unimportant in the regard of the inquiry in hand.

The Bulletin pretends to give "fully 90% of the *total* tonnage and all of the important tonnage of the Great Lakes," for the several years 1886-7-8-9 and 1890. It gives less than 82% of the total tonnage for 1889. As to "importance" of the several classes of vessels in service one would say that the existence of a class is sufficient proof of its "importance." But that is "neither here nor there" just now. The Bulletin omits (in 1889) 370 steam vessels and 365 sail vessels; in all, 735 craft. It shows only 1,065 steam, and 882 sailing, while my tables (pp. 82-83 of Ship Canal Report) show 1,247 sail, and 1,435 steam, and its omissions in 1890 are not consistent with its omissions in 1889.

I trust that the Bulletin (No. 29) will not be given a place in the final Census Returns. Bulletin No. 66 (May, 1891) gets the numbers of vessels on the lakes pretty nearly correct (for 1889). It shows on Northwestern Lakes (exclusive of the Champlain and St. Lawrence River) 1,432 steam vessels, and 1,259 sailing vessels (Dec. 31, 1890). As above noted I show 1,435 and 1,247 respectively. I see no good in talking about "Bulletin No. 29" now, except when occasion directly calls for some explanation of the methods followed in making up that document. Such explanation I make in the printed sheets herewith (see p. 2 thereof), giving the facts without extended comment.

The printed matter (inclosed) explains itself. The compilations necessary in making up of the tables, etc., therein have been made by myself, and I have spared no pains necessary to accuracy. The concluding paragraph suggests the policy that will, I believe, recommend itself to the ship-owners of the lakes. Why waste great sums in futile efforts to make and maintain "20-ft. channels," etc., in persistent opposition to the forces of nature, when results equivalent to those sought through the making of the "20-ft. channels" may be had by the simple process of giving your freight-carriers a little more beam.

Yours very truly,

J. W. GOODWIN, Commissioner.

[We expect to publish some further and more elaborate data on this subject from Mr. GOODWIN, and will defer any comments until then.—ED. ENG. NEWS.]

Sir John Hawkshaw, F. R. S.

The name of Sir JOHN HAWKSHAW, the great engineer, who died in London on June 2, is as well known in America as in England, and the following sketch of his life, from a somewhat fuller biography in *Engineering*, will be interesting to American engineers:

JOHN HAWKSHAW was born in 1811, in Leeds, and was educated at the grammar school of that town. At an early age he entered the office of Mr. CHARLES FOWLER, a celebrated road maker; but preferring railways to highways, he was soon removed to the office of Mr. ALEXANDER NIMMO, who was at the time engaged upon a scheme for a railway between Manchester, Leeds and the Humber. Mr. NIMMO died in 1831, and some of his clients sent young Mr. HAWKSHAW to manage some Bolivian copper mines, and he remained in South America for three years.

Upon his return to England he published a book entitled "Reminiscences of South America, from Two and a Half Years' Residence in Venezuela." He then became an assistant to the late Mr. JAMES WALKER, and married, in 1835, the daughter of the Rev. JAMES JACKSON, of Green Hammerton, Yorkshire. At the age of 26 he was appointed Engineer to the Manchester & Bolton Canal & Ry., which later was a part of the extensive Lancashire and Yorkshire system, of which he eventually had charge.

About this time he was consulted by the directors of the Great Western Ry. as to the desirability of maintaining and extending the broad-gage system, then only in operation between London and Maidenhead. His report, elaborately defending the narrow gage as the most economical, first made known his great ability and brought him into prominence as an engineer, though BRUNEL'S genius carried the day with many large shareholders.

In 1840 Mr. HAWKSHAW succeeded Mr. GEORGE STEPHENSON, when that gentleman retired from active service, as engineer of the Manchester & Leeds Ry. He eventually developed this system until it covered 428 miles. He worked a steep incline at Halifax, with grades of 1 in 44, with ordinary locomotives; and by so doing broke down the prevailing prejudice against steep grades, and made railways possible in regions before considered inaccessible by rail.

Work flows in rapidly to the successful engineer, as the following list of a few of the undertakings about which Mr. HAWKSHAW was consulted will show: The Riga & Dunaberg and the Dunaberg & Witepsk railways, in Russia; the Penarth Dock and dock in Cardiff Roads; Londonderry Bridge, Ireland; Charing Cross and Cannon St. bridges and stations, with the connecting line; the East London Ry.; the Government railways in Mauritius; the Albert Docks, Hull; the south dock of the East and West India Docks; the foundations of the forts at Spithead; the ship canal from Amsterdam to the North Sea. Mr. HAWKSHAW was also for many years consulting engineer to the Madras Ry. and the Eastern Bengal Ry.; he was also referee to the San Paulo Ry., in Brazil.

Among other undertakings not mentioned was the completion of Holyhead Harbor, after the death of Mr. RENDEL in 1856. This was a work of national importance, and on its formal opening the honor of knighthood was conferred on the engineer in 1873. Another government enterprise intrusted to Mr. HAWKSHAW was the examination of the various schemes for the supply of Dublin with water. This was in 1860; the Vartry scheme which he recommended was carried out. In 1862, very shortly after the bursting of the St. German's sluice of the Middle Level, Mr. HAWKSHAW was called in to advise upon and carry out the best means for excluding the sea from the large tract of low-lying land then inundated. He replaced the sluice by 16 large siphons and thus averted all danger of a repetition of the former catastrophe. In 1863 Mr. HAWKSHAW contested Andover, but failing he never again sought Parliamentary honors.

In 1862 Mr. HAWKSHAW went to Egypt as consulting engineer to report on the works of the Suez Canal. He had no difficulty in deciding that it did not present any insuperable engineering difficulties, a conclusion that would not be acceptable to Lord PALMERSTON. On a second visit he surveyed the Nile between the first and second cataract, and proposed works to render it navigable as far as Wady Halfa. From there he advocated a railway to Khartoum. In 1865 he became, in conjunction with Mr. J. DIRKS, engineer to the Amsterdam Sea Canal, a direct navigable channel, 15½ miles long, from Amsterdam to the North Sea, intended to supersede the North Holland Canal of 52 miles long. The canal has a depth of 23 ft., with a clear width at the top of 197 ft. But the Severn Tunnel will rank as Sir JOHN HAWKSHAW'S greatest engineering feat, in view both of the commercial importance of the work and of the physical obstacles which were overcome. During the thirteen years when the tunnel was under construction, the influx of water was so constant and copious that fears were frequently entertained as to the possibility of completing the work. But Sir J. HAWKSHAW'S skill and perseverance placed the issue beyond doubt even before 1885, when the first train passed under the river between England and Wales. Before he commenced this work he had already proposed the boring of a tunnel between England and France, and had made a number of borings and soundings, partly at his own expense. His opinion was entirely favorable to the scheme; there are, however, other considerations than those of an engineering nature to prevent its execution.

Mr. HAWKSHAW was elected an Associate of the Institution of Civil Engineers on February 16, 1836. On August 7, 1838, he became a member, and in 1862-63 he filled the presidential chair. November 3, 1880, he was made an Honorary Member of the American Society of Civil Engineers. He was also a Fellow of the Royal Geographical Society and of the Royal Society, and a Knight Commander of the Brazilian Order of The Rose. In 1875 he was the President of the British Association, which that year met in Bristol.

Mr. HAWKSHAW early established a high reputation as a Parliamentary witness. The care and precision with which his evidence was always given, and the fact that both from high conscientiousness of character and great powers of memory he was never found to contradict himself, no matter after what interval of time, gave to his testimony great weight and value. For some years past he had relaxed his professional exertions, and on December 31, 1888, he definitely retired, leaving his business to the care of his son, Mr. JOHN CLARKE HAWKSHAW, and to his partner, Mr. HARRISON HAYTER.

A New Cable-Road Conduit.

The illustrations here given show a new form of cable conduit designed to meet not only the conditions required for cable traction, but also to provide space beneath the street surface which can be most usefully occupied by the various pipes, electric wire conduits, etc., now simply buried under the pavement.

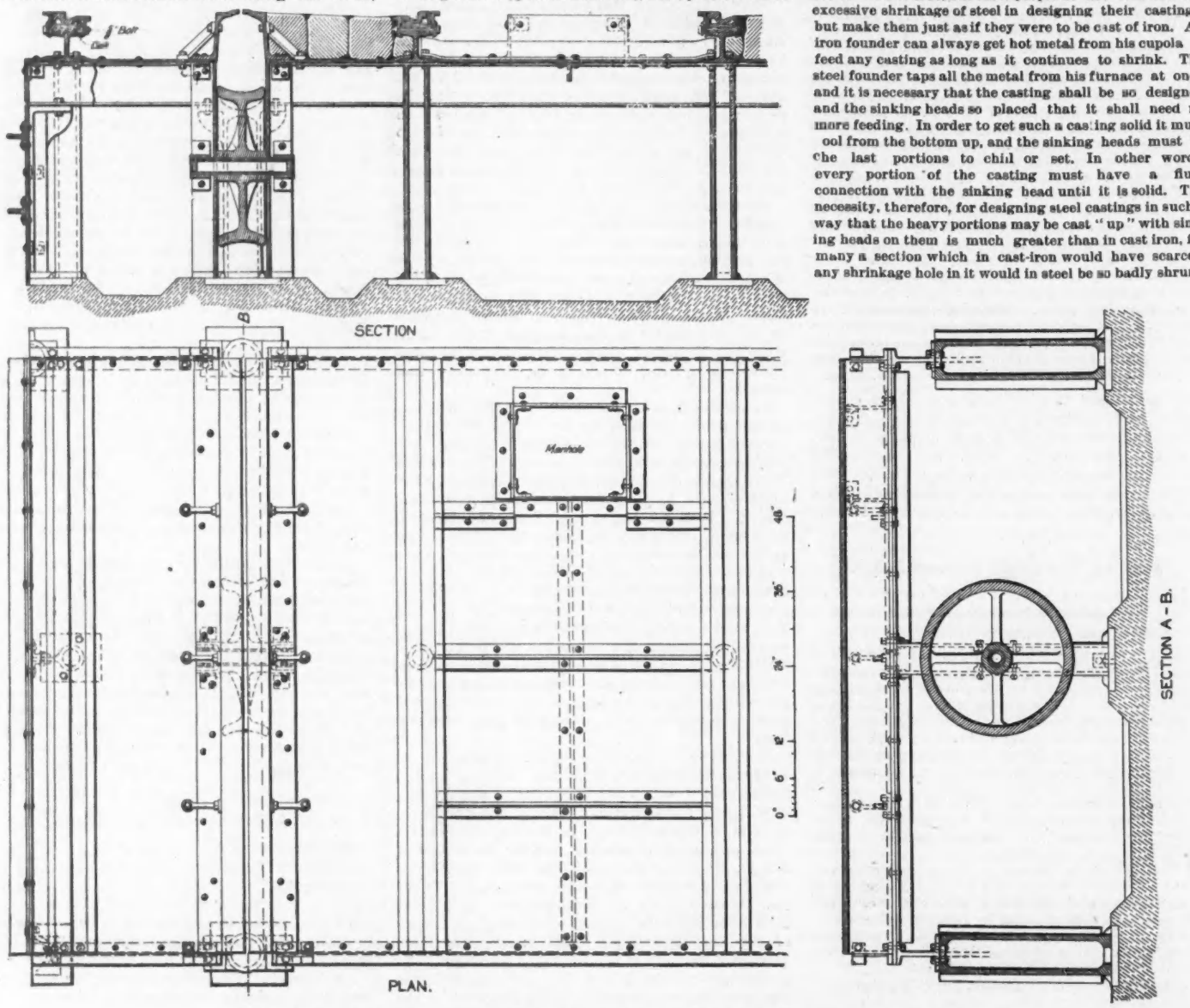
As shown in the cross-section and plan, short cast-iron posts support a framework of I-beams, which carry the street pavement on a plain or buckle-plate roof. Beneath the lines of slots for the grip-plates, the large carrying pulleys for the cables are arranged as shown. The side-walls are shown as made of iron, but brick or stone can be substituted.

The chief and the valuable feature in this form of construction is that aside from the benefits arising from the substitution of cable traction for horses, a roomy subway is provided beneath the street for other purposes. Water and gas pipes, pneumatic tubes, electric light and telegraph and telephone wires could be systematically disposed in such a conduit, and so placed that access to each or any of them would be comparatively easy, for connections or repairs.

This subway could be confined to the limits of the railway tracks, as shown, or extended beyond these tracks when more space was needed. The height available is controlled only by the length of the posts used. The pavement resting upon this subway need never be disturbed, except for renewal, as manholes at proper intervals would admit workmen and materials beneath it at any time. Water pipes and gas pipes could be so supported and laid that leaks should rarely occur, and when they do the leak can be easily located and repaired. Connections with the houses on either side would be made by boring through the intervening soil and inserting a pipe;

and for this reason the brick side wall would be preferable to iron, and doubtless cheaper.

The expense of the iron construction would be comparatively great. But this expense must be offset by the greater expense, with present methods, of constantly breaking the street surface for additions and connections to the network of underground pipes and conduits, and the greater nuisance still of obstruction to street traffic while doing this work,



CONDUIT FOR CABLE-TRACTION AND UNDERGROUND PIPES AND WIRES. R. T. White, Inventor.

and between times having a bad pavement, no matter what the style of pavement or cost may be.

This conduit is the invention of Mr. R. T. WHITE, Mills Building, New York, who will doubtless answer all further inquiry.

Steel Castings.*

During the past few years steel castings have come extensively into use in the construction of machinery. The great power and size of many machines now being built demand a metal stronger than cast iron, and steel seems to be the most suitable substitute. Steel castings, however, have not given universal satisfaction by any means.

VARIATIONS IN SIZE.

One man complains that they are not true to pattern; he has been using iron castings and expects those of steel to be as accurate as the iron ones. A little consideration will show that such expectation is unreasonable. Steel castings not only shrink much more than iron ones, but with less regularity. If iron castings are made from approximately the same grade of metal, they will be very nearly uniform in size. With steel castings the amount of shrinkage varies with the composition and the heat of the metal: the hotter the metal, the greater the shrinkage; and as we get smoother castings from hot metal, it is better to make allowance for large shrinkage and pour the metal as hot as possible. Then all castings should be thoroughly annealed, and in doing this a heavy scale is formed, leaving the casting pitted; this is very marked if the metal has been a little cool in pouring. We must not therefore expect to find steel castings as true to pattern as iron ones. The safest thing to do is to allow $\frac{1}{16}$ in. or $\frac{1}{4}$ in. per ft. in length for shrinkage (except in very heavy castings where $\frac{1}{8}$ in. is sufficient), and $\frac{1}{4}$ in. for finish on all machined surfaces except such as are cast "up." Cope surfaces which are to be machined should, in large or hard castings, have an allowance of from $\frac{5}{8}$ in. to $\frac{1}{2}$ in. for finish, as a large mass of metal slowly rising in a mold is apt to become crusty on the surface, and such a crust is sure to be full of imperfections. On small, soft castings $\frac{1}{8}$ in. on drag side and $\frac{1}{4}$ in. on cope side will be sufficient. No core should have less than $\frac{1}{4}$-in. finish on a side, and very large ones should have as much as $\frac{1}{2}$ in. on a side. This seems a great deal, but will be found economical in the long run.

BLOW HOLES AND SHRINKAGE HOLES.

Another man will say that so many castings have "blow holes" in them. This is undoubtedly true; but unless the holes are so large as to make the appearance of the casting very bad, or occur on a wearing surface, they should not give any anxiety, as such metal is always tougher than solid metal of the same hardness. Blow holes can be entirely prevented in castings by the addition of manganese and silicon in sufficient quantities, but both of these cause brittleness, and it is the object of the conscientious steel maker to put no more manganese and silicon in his steel than is just sufficient to make it solid. Working with this object in view, he occasionally fails to get quite enough in to make his castings entirely free from blow holes, while one who is simply aiming at solid castings regardless of quality, gives his metal a dose of silicon which is sure to make it solid, and if there should already be a little more silicon in the metal than he is counting upon, his castings will be beautifully smooth and solid, but brittle and far inferior to those with the blow holes in them. If such castings are to replace iron ones which have broken, they will, as a rule, be good enough; but if they are for new work and good tough castings have been counted upon, they will be very apt to fail.

Another complaint is that many of the heavy sections on being cut into are found to contain large shrinkage holes. This is true, but most people do not consider the excessive shrinkage of steel in designing their castings, but make them just as if they were to be cast of iron. An iron founder can always get hot metal from his cupola to feed any casting as long as it continues to shrink. The steel founder taps all the metal from his furnace at once and it is necessary that the casting shall be so designed and the sinking heads so placed that it shall need no more feeding. In order to get such a casting solid it must cool from the bottom up, and the sinking heads must be the last portions to chill or set. In other words, every portion of the casting must have a fluid connection with the sinking head until it is solid. The necessity, therefore, for designing steel castings in such a way that the heavy portions may be cast "up" with sinking heads on them is much greater than in cast iron, for many a section which in cast-iron would have scarcely any shrinkage hole in it would in steel be so badly shrunk as to be unfit for use. It will follow also that the section of the sinking head must be greater than any portion of the casting to enable it to retain its heat until the whole of the casting is set.

The best results are arrived at when all portions of the castings are of a uniform thickness, or very nearly so. In such a case there is but little danger of shrinkage holes, and the even cooling will, as a rule, cause the casting to retain its shape and be true to pattern, while those in which the sections vary very much in thickness are apt to depart a good deal from the pattern by warping from unequal cooling.

CRACKS, AND HOW TO AVOID THEM.

Another and very serious trouble is the tendency which castings have to crack in cooling. These cracks or "pulls," as they are generally known, take place just after the steel has passed to the solid state and when it is still greatly lacking in tenacity. The contraction of the casting begins very soon after it has become solid, and unless every portion is free to shrink there may not be strength enough in the metal to overcome the resistance offered by the sand in the mould and to pull the different parts together, and a crack will open in the hottest or softest part. If there is much variation in the thickness of the metal, it is almost impossible to prevent the formation of cracks where heavy and light sections join. If, on the other hand, the casting is of uniform thickness throughout, such a tendency is reduced to a minimum, as there are no very soft places for cracks to start. All inside corners should have

*A paper by H. L. GANTT, Supt. Casting Dept. Midvale Steel Works, Philadelphia; read at the Providence Meeting of the American Society of Mechanical Engineers.

large fillets in them, as such corners when sharp almost always crack open. The tendency of castings to "pull" makes it very desirable that they should be as simple in construction as possible. For instance, it is better to bolt several small castings to one large one than to complicate the large one by casting small projections on it. In case of the built-up structure we know exactly what we have, but when a number of brackets and knobs are cast on we may never know the cracks or defects until something breaks off.

The principal cause of the difficulties in filing specifications on castings for the United States Navy Department is that all designs are made, not with special reference to avoid difficulties in casting, but with the purpose of getting the strength needed with the least possible weight of metal. The result is that the castings are often very complicated and as each new shape is necessarily an experiment, are very expensive. In many cases, also, there are no doubt shrinkage holes in the centers of the castings, but usually such holes are not suspected until the casting breaks. In the majority of such cases the steel founder has done all he can to prevent shrinkage, but the design of the casting is such as to cut off fluid connection from the sinking head to some portions of the castings before such portions are set. Steel founders should decline to make such castings as will surely contain serious shrinkage holes, or at least warn their customers that such will be the case, and make an effort to have the design modified. It is a good plan for those not practically familiar with the manufacture of steel castings to submit to those who are, designs of any large or important castings before making the patterns, as in many cases unimportant changes may be made in the design and much better castings secured. Work will often be much expedited by consulting the founder about the way of making the pattern, as it is often necessary to pour a steel casting in a position very different from that in which an iron one would be cast.

ANNEALING CASTINGS.

In the earlier part of this paper it was stated that the fracture of an unannealed steel casting very much resembled that of burnt steel. The behavior of an unannealed steel casting also resembles that of an overheated forging. Its chief characteristic is its brittleness when subjected to shock. Hard castings have this property to such a marked degree that sinking heads are often broken off by the shock of chipping off the runner, in which case they nearly always carry a large piece of the casting with them. Such castings, unless containing large amounts of manganese and silicon, become tough and reliable when annealed, and show a fine, even grain upon fracture. Another effect of annealing is to equalize the strains of cooling. These strains are sometimes so great as to cause the casting to crack open with a loud report. This happens not only in hard steel, but also in steel low in carbon. As an illustration of this the cracking of a large gear-wheel may be cited weighing 8,000 lbs. (carbon, 0.34%). The wheel had been cast several days and was about half-cleaned. It was left in a perfect condition one evening and found next morning with a crack half-way across one of the arms.

The following table will illustrate the effect of annealing on tensile strength and elongation:

	UNANNEALED.		ANNEALED.	
Carbon.	Tensile strength, lbs.	Elongation.	Tensile strength, lbs.	Elongation.
.23%.....	62,738	22.40%	67,210	31.40%
.37%.....	85,540	8.20%	82,228	21.80%
.53%	90,121	2.35%	106,415	9.80%

In the above table the unannealed and annealed specimens having the same carbon were in each case taken from the same runner of a casting and very close to each other. On considering this table the value of annealing becomes immediately evident, as does the absolute necessity for it in the case of hard castings. The proper annealing of large castings takes nearly a week, and when we remember that all steel castings are made in dry sand molds, and have sinking heads on them, which in most cases have to be cut off in the machine shop, it will be evident that they should be ordered three or four weeks before they are needed.

HARD AND SOFT CASTINGS.

One more complaint of frequent occurrence is that the metal is too hard or too soft, no specifications having been given except that the castings shall be of steel. In such a case the manufacturer has probably put in the casting the grade of metal which he considered best for the work it was to do, but his judgment will often differ from that of the purchaser. Our experience with steel gears, and especially with roll pinions, is that they do not break, as a rule, but wear out. Consequently we make them hard, pinions being made hardest. The result of this has been that some have complained that they were so hard they could not be machined. For people who have their machines speeded to cut cast iron only, they are of course too hard; but if it is desired to get good wear it is much better to slow down the machine and use hard steel for such castings. One objection to hard steel is the tendency which it has to form blow holes, and consequently the strong inducement to add large quantities of silicon and manganese to the metal to make it solid. It is in high carbon steels that silicon is specially objectionable; for while annealing will greatly diminish brittleness due to carbon, it does not appear to have much effect on that due to silicon. Another essential in the production of solid castings of high carbon steel is that the metal shall be very hot. Consequently small castings and those having very thin sections will often contain blow holes, while a thick, heavy casting made from the same metal will be perfectly solid. As large and small castings are usually made from the same ladle of metal, it is considered preferable to run the risk of having a few blow holes in small castings rather than have the large ones unnecessarily brittle. Such blow holes are usually very close to the surface and may in general be gotten rid of by allowing a little extra metal for machining. In the case of small gearing they show up in the teeth, but our experience has been that such gears wear far better than softer ones, which can easily be made solid.

The proper steel for roll pinions, hammer dies, etc., seems to be that containing about 0.60% of carbon. Such castings properly annealed have worn well and seldom broken. Miscellaneous gearing should contain carbon 0.40% to 0.60%, gears large in diameter being softest. General machinery castings should, as a rule, contain less than 0.40% of carbon, those exposed to great shocks containing as low as 0.20% of carbon. Such castings will give a tensile strength of from 60,000 to 80,000 lbs. per sq. in., and at least 15% extension in a 2 in. long specimen.

Machinery and hull castings for the war vessels now being built for the United States Navy, as well as carriages for naval guns, contain from 0.20% to 0.30% of carbon. The smaller gun carriages are subjected to a ballistic test, in which the casting is pierced by two shots from a three-pounder Hotchkiss rapid-firing gun, the shots striking not less than four diameters apart. If the metal shows a tendency to crack seriously, the casting is condemned, as are all others made from the same heat. Castings for the hull and machinery of the ship are subjected to a bending test, in which an inch square bar is bent at right angles around a radius of 1½ ins. If the bar shows any serious cracks the casting is condemned.

COMPARATIVE ECONOMY OF STEEL AND IRON CASTINGS.

In designing machinery the question often arises as to which will give the desired result most economically, a steel or an iron casting, and is sometimes quite difficult to settle without making both designs and getting prices. If a few facts about the relative size of steel and iron castings of the same strength be borne in mind, they will greatly help us in this matter.

With reference to strength, it has been noted that good castings for general machinery work will give 60,000 to 80,000 lbs. tensile strength and 15% extension. Where strength and not stiffness is required, a structure of such material will resist a strain of 15,000 lbs. per sq. in. with greater safety than one of cast iron will resist 5,000 lbs., especially if subjected to shocks. It follows then that if the castings are large, a steel casting to stand the same strain as an iron one need only be about one third as heavy. In the case of small castings the use of steel will generally allow us to make them somewhat lighter, but the same proportion will not hold good, as the difficulty of making a perfect steel casting increases very rapidly as the sections become very thin. In general, small steel castings will be found to cost proportionately more and to be less satisfactory than large ones. They come into use where iron castings will not answer, while large steel castings will often take the place of iron ones on the score of cheapness alone.

The following is a partial list of castings in which steel seems to be rapidly taking the place of iron: Hydraulic cylinders, cross-heads and pistons for large engines, roughing rolls, rolling mill spindles, coupling boxes, roll pinions, gearing, hammer heads and dies, riveter stakes, castings for ships, car couplers, etc.

Perhaps the one class of castings which is of most general interest is that of gearing. A few years ago steel castings were so rough that it was necessary to cut all steel gears; but now this difficulty has been practically overcome, and while they will never be as smooth as good iron ones, uncut steel gears, even of small sizes, are giving perfect satisfaction in many places, and are now used by the Midvale Steel Co. almost to the entire exclusion of iron ones.

DISCUSSION.

Mr. W. O. WEBBER said that the author had omitted to mention the chief difficulty in the use of steel castings, which is, that while the manufacturer promises to deliver them to you in three weeks you don't get them for three months.

Mr. OBERLIN SMITH described in a somewhat facetious manner his experience: Steel castings are apt to be either good or bad, and you don't know which. On the whole we have had good results from their use, especially for shafts with cams on them, running against steel rollers, as used in press building. The hardest cast iron will soon wear and crumble under this service; but the steel shafts and cams will run for years, the cams keeping a polish like a mirror. The shafts are found to wear better in cast-iron bearings than do steel forgings. The cast steel seems to be better able to retain the lubricant than either cast-iron or forged steel. We have not found any difficulty in securing good castings of tolerably complicated forms, and think there has been an improvement of late in the quality of steel castings. Mr. J. L. GOBEILLE said that the fault when a steel casting fails is generally in the design of the pattern. Steel founders are working against their own interests in trying to make complicated castings about whose design they have had nothing to say; but most steel founders nowadays have a small Bessemer plant and a cupola as well about their works. If they fail in making the casting at first they try it in Bessemer steel, and if that fails they make it in plain cast iron and send it along, trusting their customer won't know the difference. Mr. E. F. C. DAVIS, of the Richmond Locomotive Works, praised the castings furnished to the Government for the new cruiser *Maine*, many of which were seen by the society at the Richmond meeting. They are sound and free from blowholes, and are tough, good metal. Certainly there are steel founders who can turn out steel castings with some degree of certainty as to the character of the product. In building the machinery for the *Maine* there has actually been more difficulty in getting good steel plates for the boilers than in getting steel castings. Another member said he was glad to hear the author speak a good word for blowholes. They were an evidence of toughness in the steel, and in many cases did no harm whatever. Yet a recent piece of Government work had been condemned because of surface blowholes in the steel, although the highest test pressure called for was sustained perfectly. It was also suggested as an evidence of the reliability of steel castings that the Westinghouse Brake Co. now use steel fittings throughout.

Mr. H. M. HOWE asked if careful experiments had been made to ascertain whether shrinkage varied with the chemical composition of the steel. If it did it was not generally known. Getting good steel castings is largely a matter of trick and knack, and one of the chief tricks is to provide plenty of feeding capacity for the casting. A wrinkle little known in this country, but considerably practiced on the other side of the water, in the Sheffield steel plants, for instance, is to have a white-hot top to the mould into which the metal is poured. This keeps the steel in the sinking head fluid for a much longer time than would otherwise be the case and gives sound castings. It is even used for steel ingots to prevent piping; and if it is needed for ingots, which are to be rolled and worked, it seems quite as important for castings, which are used without further working. A plan for preventing the pulling apart of the casting in cooling and shrinking at points where a heavy section meets a light one, is to make a thin bracket or fin connecting the two. This cools and gets strong enough to hold the two parts together before the rest of the casting begins to shrink.

Mr. THOS. R. MORGAN, Sr., said that an extensive experience in the use of steel castings had convinced him that the difficulties of which so much had been said were commercial rather than mechanical. To make good steel castings it was necessary to have a more intelligent class of workmen than the ordinary iron-moiders, and these men commanded higher wages. Again, to make a sinking head 50%, 75% or even 100% of the weight of the casting is an expensive thing; but it is often necessary to get the best results. He had had many fine castings from the Solid Steel Co., of Alliance, O., and thought that much of their success was due to the fact that they carried their runners higher than other firms. The Government is getting splendid steel castings right along, and has no difficulty in doing so, but it pays a price for them which many private firms would consider excessive.

Mr. O. O. WOOLSON agreed with the author that it was better to bolt on projecting parts than to try to make too complicated castings.

President HUNT said too much must not be made of the difficulties experienced with steel castings. When steel rails were first introduced a great hue and cry was made every time a rail was broken, it being quite forgotten that breakages with iron rails had been a serious matter. So although steel castings may sometimes fail, it should be remembered that iron castings have done the same. It is evident that steel castings have come to stay. Plants which a few years ago turned out two or three tons a week, now think nothing of making a hundred tons in the same time; and new plants are starting up all the time.

In closing the discussion the author said that it was quite true that complicated castings could be made of steel, but each one is an experiment. As for blowholes, there is no difficulty in avoiding them when using soft metal; but as the percentage of carbon rises and the metal becomes hard, it becomes a difficult matter to get castings of small size free from blowholes. In answer to a question concerning annealing, it does not take a week to anneal a casting theoretically; but as large and small castings are put in the annealing oven together, and as it does not pay to run the risk of breaking the large castings by heating them too rapidly, the annealing oven is heated very slowly. Concerning the use of a fin, spoken of by Mr. HOWE, every one does that and uses a fillet besides; but neither of these can wholly make up for bad design in the pattern. To show what care some manufacturers take to secure good castings, he said that a drawing is made of the casting and sinking head of each large and complicated cast-

ing. When a new casting of a different pattern is to be made, these drawings are referred to, and an idea is gained of the form and size of sinking head necessary. As for delays in delivering, the necessity of annealing and removing the scale, with extra care in the foundry, takes a little time; but he did not believe that deliveries were, as a rule, any slower than in the case of other machinery.

Exhaust Pipes, Nozzles and Steam Passages.

The following is the report nearly in full of the committee of the American Railway Master Mechanics' Association, presented at the annual meeting at Cape May, N. J., a report of which is given on another page.

At the Old Point meeting your committee reported, in substance, that the establishment of definite proportions of exhaust pipes relative to other parts of the locomotive was an impossibility, owing to the fact that so many variables would have to be taken into consideration; that no formula with which we were acquainted or could devise would meet the conditions. This being the case, we can but suggest certain relations between different dimensions of the pipes, without regard to any one dimension of the engine, leaving to users the choice of size of pipe which will best suit local conditions.

We hold that the aim of the designers should be:

1. To choose such size and shape as to secure free steaming.

2. The exit of the steam should be as free as possible to avoid injurious back pressure.

3. The discharge should be as nearly central with stack as can be, so to produce maximum effect.

4. Exhaust from one cylinder should not blow over into the other.

5. The exhaust pipe should terminate at such distance from base of stack as to insure its being completely filled at each discharge.

The roads with which members of your committee have been connected use single pipes almost exclusively, and we consider that the conditions as above laid down are best fulfilled by that pattern, still we are familiar with the results obtained with double nozzles.

In designing single pipes we hold that the most vital point is the relative areas at tip and at combining point. Where the area at the combining point is largely in excess of the area of the tip, it will inevitably result in blowing over the bridge, raising the back-pressure line into the well-known hump. On the other hand, where the area at tip is the larger, it will be found that the velocity given to the steam at the bridge will, provided the form is easy, carry it past the tip without any tendency to blow over.

It has been clearly shown that the height of the bridge cuts no figure in effecting back pressure, but that lowering the bridge affords the designer a chance to straighten the discharge before it leaves the pipe. We suggest that the distance be made from 3 to 4½ times diameter of tip and that sudden changes in form be as far as possible avoided, both because of the increased resistance to free exit, and also because the eddy caused by sudden enlargement or contraction causes deposit of gas carbon from cylinder oil at these points.

We do not think that the pipe should be regarded as a reservoir, because such treatment so prolongs the discharge of the steam that the pressure is not relieved when the piston begins return stroke.

We consider that the pre-release affords ample time to discharge the steam. The height of the pipe should be such as to insure that the base of stack shall be completely filled at narrowest part. If, however, it be more than filled, an injurious eddy is formed. We think that the general practice is to put the pipe too high. Where care is not taken to insure straight discharge, part of it impinges against side of stack with injurious results to steaming. Raising the pipe, of course, obviates this trouble in a measure.

In trials made some years ago with a telescopic pipe it was found that tip could with benefit to steaming be lowered nearly to center line of boiler, and your committee is of the opinion that where a pipe is of such shape as to insure central and solid discharge the best results will be had with tip from 20 to 25 ins. from base of stack. There is reason to believe that exhaust entrains a considerable quantity of smoke-stack gases before reaching base of stack, and where circumstances require a very short smoke-stack we strongly urge lowering the tip of pipe.

Committee has experimented with petticoat pipe, and derived no benefit from its use, except where the exhaust was inclined to cross over. We think that this is remedying a defect which should not exist.

As proof of the correctness of these conclusions we submit set of cards taken by Mr. James Meehan, of the C., N. O. & T. P. Ry. (Figs. 5 and 6), who tested the pipe designed by the committee against others of different forms. We also submit cards taken by a member of committee, together with cut of pipe used (Figs. 3 and 4).

The engine tested by Mr. Meehan was an 18 in. × 24 in. cylinder Baldwin passenger engine with 68-in. drivers. Pipes 1, 2 and 3 were tested in succession. Pipe No. 5 was tested on 17 in. × 22 in. cylinder passenger engine.

Pipe No. 2 is a development of the one submitted at the last meeting, but to test our theories we reduced area at bridge to 80% of tip area, and also reduced the height of bridge. The reason for flattening the pipe was to straighten the discharge, and also to see whether an upward current could be induced in opposite cylinder.

It will be noticed that in Fig. 6 pipe No. 2 shows decidedly best results, and, as Mr. Meehan reports, gave decidedly best results in steaming. When tried against pipe No. 3, on 20 in. × 24 in. cylinder consolidation on (Fig. 5) it shows conclusively that reduction at combining point has been carried too far. It will, however, be noticed that in none of the cards does pipe No. 2 show any tendency to blow over the bridge.

In explanation of these cards it should be stated that the vacuum shown is not to be implicity relied upon, as the gage was so sensitive as to be affected by motion of engine. The results can fairly be compared with one another. Attention should also be called to the difficulty in determining the vacuum in smokebox. The fluctuations in pressure are so rapid that no measuring device that we have seen will give more than a mean reading, which is not what is needed.

The only solution that we can suggest is to construct an indicator, which will transmit the action of vacuum on a diaphragm to the pencil motion of an indicator, so that smokebox diagram can be taken on regular card. In this way only does it appear possible to settle the question raised by some members, which is: "Does not a very large and free exit of the steam exert most injurious result on the fire due to suddenness?"

In cards shown vacuum is given in inches of mercury. Multiplying this by 13½, to give equivalent height of water column, gives such an excessive figure that we caution members against accepting them absolutely.

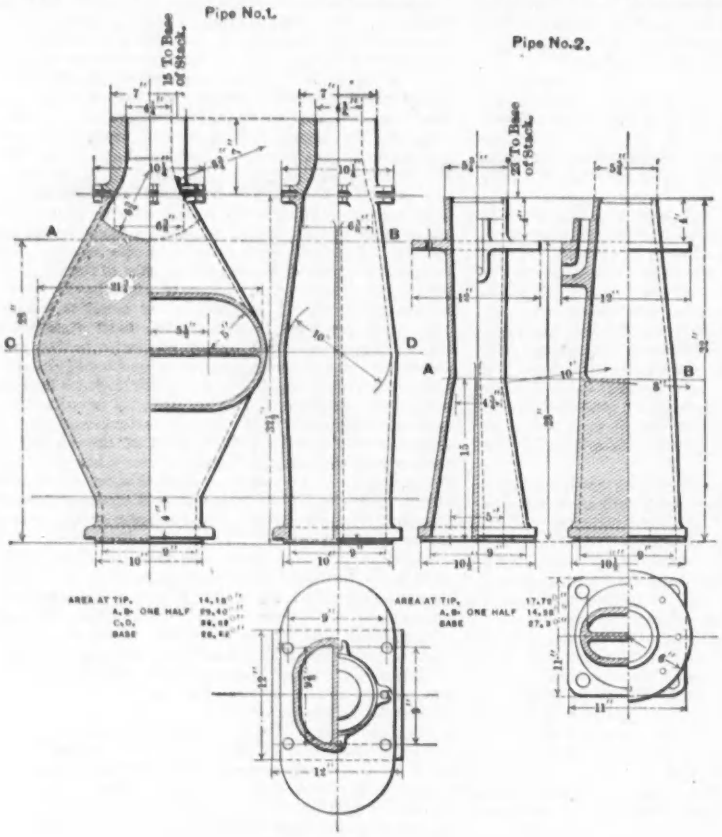


FIG. 1.

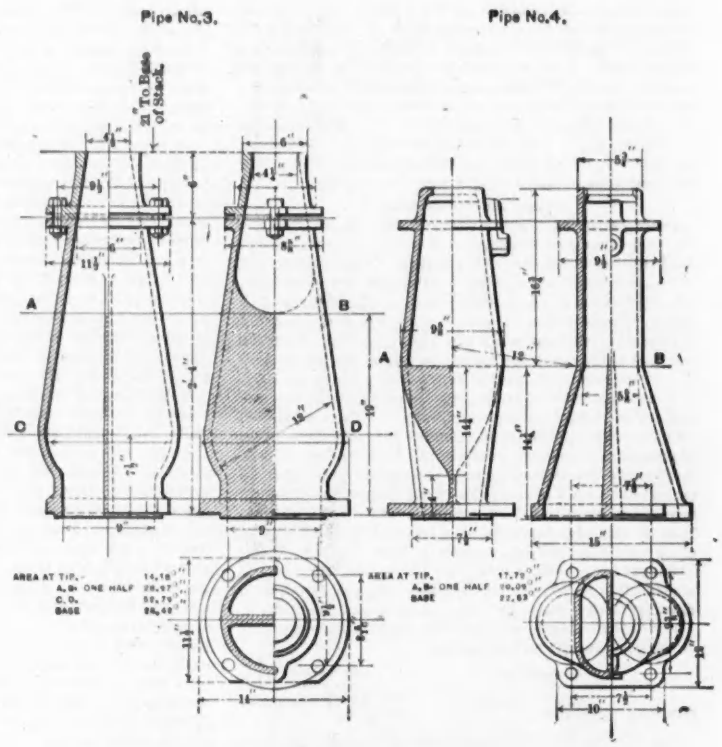


FIG. 2.

The following table gives the dimensions of the pipes tested:

DIMENSIONS OF PIPES TESTED.

	No. 1.	No. 2.	No. 3.	No. 4.
Area at base	28 42	27.3	28.42	22.69
Area largest point	87.	27.3	52.79	22.69
Area top of bridge	29.4	14.38	28.97	20.19
Area at tip	14.18	17.72	14 18	19.63
Height of pipe	40 in.	32 in.	34 in.	31 in.
Height at bridge	28 in.	15 in.	19 in.	14¼
Height of bridge to total height	.70	.47	.56	.46
Area at bridge to final area.	2.07	.81	2.04	1.13

The cards taken with pipes 1, 2 and 3 are not strictly comparable, owing to differences in speed, throttle and cut-off, but enough is shown to prove that the choking of pipe No. 2 is no detriment on the 18-in. engine. On the consolidation it is probable that both the tip and combining point areas could be enlarged with advantage. Still, it should be noted that cards 1, 2, 3 and 4, taken with pipe No. 3 (Fig. 6), are taken with part throttle, while Nos. 5, 6, 7 and 8 are with full opening.

The size of stack has a very marked effect upon the steaming with any given nozzle. Reduction of stack diameter will generally permit of increased nozzle diameter.

The committee has had considerable experience with both straight and taper form, and is of the opinion that the stack with double taper is decidedly the best, and owing to its shape, will not be subject to the same wear as the straight pattern, which, as all know, is generally cut through near the upper part. Taper stacks made in spring of 1885 are still in service.

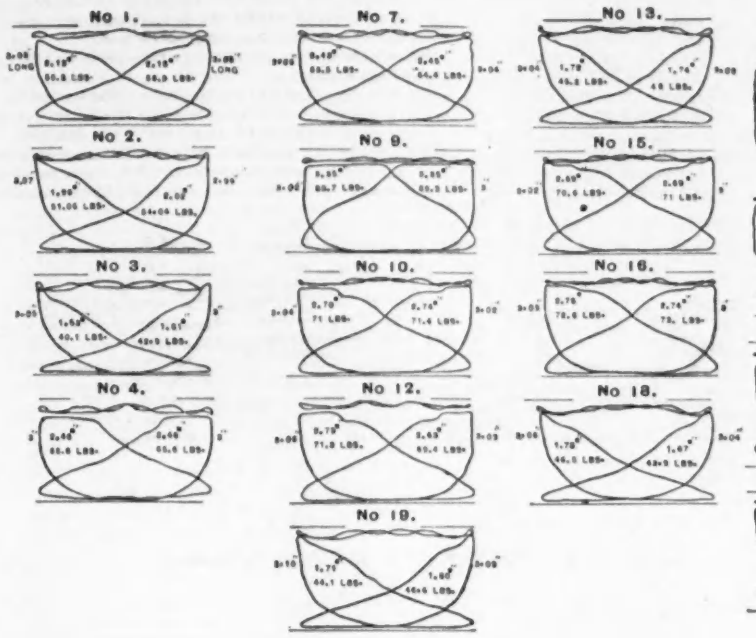


Fig. 3.

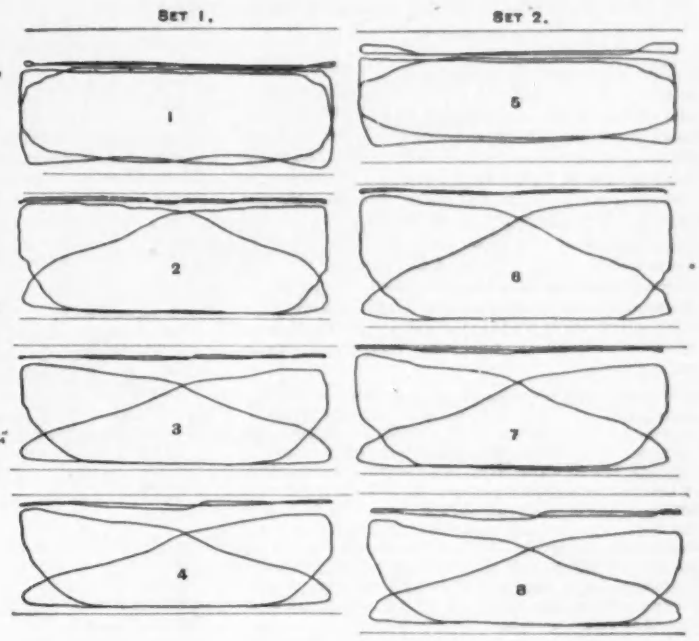


Fig. 6.

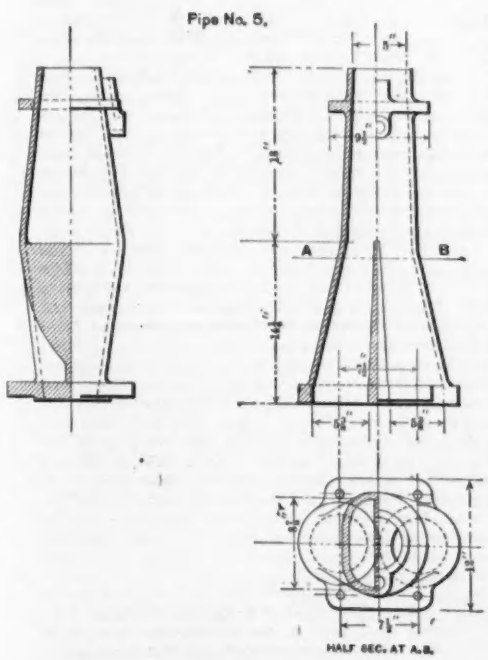


Fig. 4.

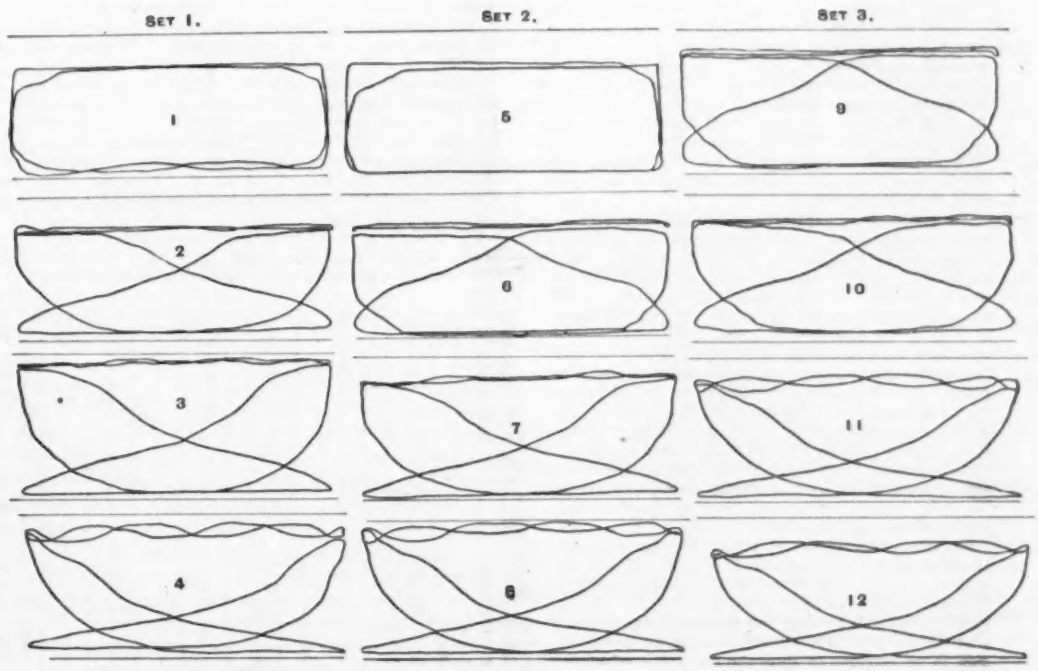


Fig. 5.

TABLE GIVING CONDITIONS OF TESTS FOR INDICATOR DIAGRAMS SHOWN IN FIG. 3; LOCOMOTIVES FROM RICHMOND & DANVILLE R. R.

Card No.	Boiler press.	Revs. per m.	Piston diam.	Piston stroke.	Piston area. Sq. in.	M. E. P.	L. H. P.	No. cars in train.	Notch.	Cut-off. F. S.	Cut-off. B. S.	Throttle.
1	140	150	17	24	226.98	56.1	350.62	5	9	7⅜	7¼	⅜
2	150	170	17	24	226.98	52.55	491.34	5	9	7⅜	7¼	⅜
3	140	314	17	24	226.98	41.5	716.70	5	9	7⅜	7¼	⅜
4	145	190	17	24	226.98	65.6	685.52	6	8	10⅝	10⅝	⅜
7	140	232	17	24	226.98	63.9	885.65	6	8	10⅝	10⅝	⅜
9	145	120	17	24	226.98	89.	567.4	6	8	10⅝	10⅝	⅜
10	145	1 6	17	24	226.98	71.2	532 57	6	8	10⅝	10⅝	⅜
12	145	154	17	24	226.98	70.3	588.41	6	9	7⅜	7¼	⅜
13	150	214	17	24	226.98	45.6	536.	6	9	7⅜	7¼	⅜
15	145	136	17	24	226.98	78.8	458.78	6	8	10⅝	10⅝	⅜
16	145	114	17	24	226.98	72.8	456.45	6	8	10⅝	10⅝	⅜
18	145	220	17	24	226.98	45.7	552.97	6	9	7⅜	7¼	⅜
19	145	218	17	24	226.98	45.3	543.14	6	9	7⅜	7¼	⅜

Area of exhaust pipe at junction, 20.28 sq. in. Single tip; area, 19.63 sq. in.

TABLE GIVING CONDITIONS OF TESTS WITH THREE SETS OF EXHAUST PIPES WITH SINGLE NOZZLES FOR INDICATOR DIAGRAMS SHOWN IN FIG. 5; LOCOMOTIVES FROM CINCINNATI, NEW ORLEANS & TEXAS PACIFIC RY.

Card No.	Boiler pressure.	Quadrant notch.	Throttle opening.	Piston speed.	Vacuum top of ex. pipe.	Average back pressure.
1	140 lbs.	9th.	⅛ in.	240 ft.	1 in.	0⅝ lbs.
2	140 lbs.	3d.	⅛ in.	912 ft.	1¼ in.	7 lbs.
3	140 lbs.	2d.	⅛ in.	576 ft.	⅛ in.	6 lbs.
4	140 lbs.	2d.	⅛ in.	960 ft.	1 in.	8¾ lbs.
5	140 lbs.	9th.	¼ in.	120 ft.	⅜ in.	3 lbs
6	140 lbs.	4th.	⅛ in.	432 ft.	⅛ in.	3½ lbs.
7	140 lbs.	2d.	¼ in.	662 ft.	1½ in.	2¾ lbs.
8	135 lbs.	2d.	⅛ in.	1,032 ft.	1⅝ in.	6 lbs.
9	140 lbs.	4th.	⅛ in.	480 ft.	1⅜ in.	1 lbs.
10	145 l s.	4th.	¼ in.	600 ft.	1⅜ in.	10¾ lbs.
11	140 lbs.	2d.	¼ in.	1.080 ft.	1¾ in.	4½ lbs.
12	140 lbs.	2d.	¼ in.	960 ft.	1¾ in.	4¾ lbs.

TABLE SHOWING CONDITIONS FOR TESTS FOR INDICATOR DIAGRAMS SHOWN IN FIG. 6; LOCOMOTIVE FROM CINCINNATI, NEW ORLEANS & TEXAS PACIFIC RY.

Card No.	Boiler pressure.	Quadrant notch.	Throttle opening.	Piston speed.	Vacuum top of ex. pipe.	Average back pressure.
1	145	14th.	⅛ in.	408 ft.	1¼ in.	13 lbs.
2	125	4th.	⅞ in.	360 ft.	1⅛ in.	6¼ lbs.
3	125	4th.	⅝ in.	408 ft.	1 in.	7½ lbs.
4	120	4th.	⅝ in.	480 ft.	1¼ in.	6 lbs.
5	130	13th.	Wide.	528 ft.	2¾ in.	19¾ lbs.
6	142	4th.	Wide.	384 ft.	1 in.	1½ lbs.
7	125	4th.	Wide	456 ft.	1¼ in.	7 lbs.
8	140	3d.	Wide.	528 ft	1¾ in.	9 lbs.

Cards 1 and 5 were taken for results of back pressure only, and were taken in full gear after the engine had attain d speed. Both exhaust pipes have single nozzles.

Proposed New Water Supply for Birmingham, England.

The large manufacturing city of Birmingham is located in the midland district of England, and is the center of an important manufacturing and mining region. The population of the city is about 462,000. A new water supply is proposed, and at the next session of Parliament a bill will be introduced to authorize the municipal authorities to construct works to bring a supply of 60,000,000 galls. per day from the basin of the Elan and Claerwen rivers in Radnorshire, North Wales, a distance of about 80 miles. The following description of the project is taken from *The Engineer*, and it will be noted that the proposition is made to furnish a supply to smaller towns or cities on the line, either temporarily or permanently:

This gathering ground was recommended to the corporation by Mr.—now Sir—ROBERT RAWLINSON as far back as 1871. At that time future difficulty began to be foreseen. With the assistance of Messrs. MANSERGH and LAWSON, Mr. RAWLINSON made a thorough examination of the capabilities of the nearer lying districts of the Severn basin, and of the valleys of the Tame, the Ithon and the Wye. The accompanying map (Fig. 1) shows these gathering grounds. In 1876 the corporation bought up the water company, and since then they have gradually developed the resources of the Blyth, Bourne, Plants, Perry and Hawthorn rivers and brooks. These drain an area of about 111 sq. miles. Several large first-class storage reservoirs have been constructed at various points in this district, the largest being the Whitacre reservoir. At Whitacre station is also constructed a modern and very powerful pumping plant. At Aston station there is also a very extensive pumping plant. In addition to these sources, water is pumped from 7 deep wells in the new red sandstone. The present expense of working and maintaining the various pumping stations is $115,000 per annum. This heavy pumping expenditure is the result of the gathering grounds lying under 300 ft. above Ordnance datum level, whereas Monument-lane, which is the chief distributing station, lies 532 ft. above O. D., and for the higher district of Edgbaston the water has to be pumped still 70 ft. higher to a service reservoir at the top of Hagley road, 60 ft. above O. D.

Altogether there are 5 service reservoirs and 8 storage reservoirs, the total storage capacity of the 13 reservoirs being about 618,000,000 galls. It will be observed that the gathering grounds and the works in general are very much scattered, making the general expenses greater than they would otherwise be for the same supply. A great deal of it is farm land, and covered by villages and farmhouses. The quality of the water is hard enough to be a source of annoyance and loss to the numerous steam-boiler users of the city, and it requires careful filtration to make it good for domestic purposes. Although its quality as delivered at present is decidedly good, it is sure to deteriorate in time, owing to the increase of population and of agricultural and other industry upon the area, and also because of the ever-increasing demand made upon the area, whereby more and more of the flood-waters would have to be impounded.

The city consumption of water has increased from 11,500,000 galls. in 1881 to 14,250,000 in 1889, and at present is increasing at a rate rather over 3% per year. In 1890 the supply was close on 5,750,000,000 galls. Fig. 2 is a diagram of the water supply and the water rental from the year 1870 to 1890. The dotted curve of water consumption is an attempt to show the mean law of increase, eliminating temporary irregularities. The dotted lines on the upper part of the water rental diagram show the rental that would have been obtained if no reduction in the water rates, such as were made in 1881, 1883 and 1884 had taken place. The diagram shows that the rental would now have been above £160,000 ($800,000) instead of £133,000 ($665,000). The dotted lines on this diagram are not "official," they have been plotted from our own calculations. The Chief Engineer of the water department, Mr. J. W. GRAY, estimates that the average daily requirement will be 17,500,000 galls. in 1893, 21,000,000 galls. in 1900, 30,000,000 galls. in 1915 and probably 60,000,000 galls. 50 years hence. The minimum supply from the present works is 17,500,000 galls. and this is not capable of much increase. Any increase at all can be accomplished only in an uneconomical and unsatisfactory manner. The corporation has therefore taken the advice of Mr. MANSERGH, who, after a renewed examination of the problem, recommends the adoption of practically the same plan as that suggested in 1871 by Mr. RAWLINSON.

The scheme now being promoted is for a daily supply of 60,000,000 galls. The masonry in culverts will be built of such size as to deliver the whole of this quantity. The length of this part of the line is about 45 miles, including nearly 9 miles of tunneling. The line, however, has to cross several rivers and to descend into their valleys. At these places the conduit will be under very considerable pressure, and the water will flow in steel pipes 45 ins. diameter. Two such pipes, together capable of delivering 24,000,000 galls. per day, will be laid when the line is constructed. Afterward, as the rising demand necessitates their addition, other similar pipes, each to carry 12,000,000 galls., will be laid. The bridges to carry these will, of course, be as first erected, all wide enough and strong enough to carry the full complement of 5 lines of pipe. The rivers to be crossed are the Wye, the Ithon, the Tame, which would be passed twice or thrice, and the Severn which would be passed some miles above Bewdley. The Severn, of course, is the most formidable to get over. The length of pipe required is about 34 miles. The line would start from near the junction of the River Elan with the Wye at Rhayadr Gwy, and pass near the towns of Knighton, Ludlow, Bewdley, Kidderminster and Stourbridge. It is more than likely that these towns, along with Cradley, Dudley, Tipton and West Bromwich, perhaps also Wolverhampton and Walsall, would wish to share in the new water supply; while the present Birmingham water-works may possibly be utilized in the future by Tamworth Nuneaton, Rugby, Coventry, Leamington, Kenilworth and Warwick.

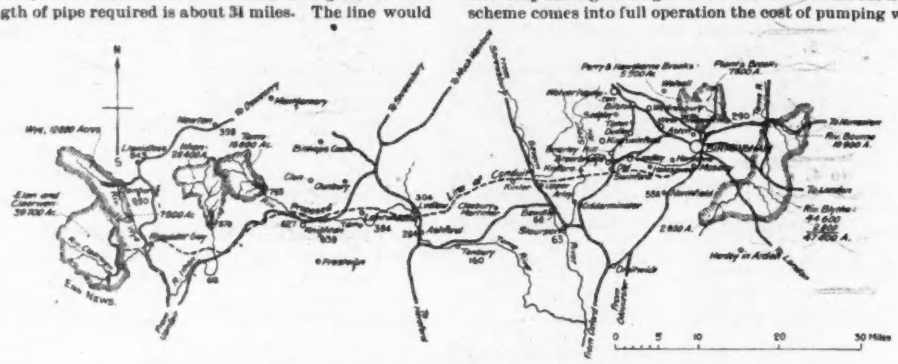


FIG. 1. WATER SUPPLY DISTRICT OF BIRMINGHAM, ENGLAND.

The water to be collected is that which drains into the Elan and the Claerwen, which are western tributaries of the Wye, themselves uniting a few miles above their junction with that river. The Claerwen forms the southern boundary of the remote western corner of Radnorshire, and the Elan runs right across this corner. The western boundary of this water shed is only 16 miles from the Aberystwith coast.

The area above the lowest of the proposed dams is 39,700 acres. Twenty years' observations give an average annual rainfall of nearly 64 ins. at the lowest level, and Mr.

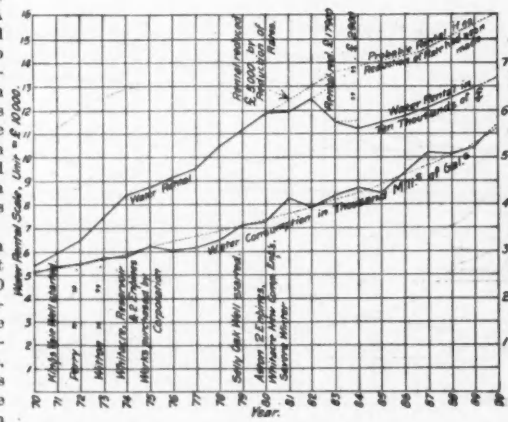

Water Rental Scale, Unit = £ 10,000
Water Consumption Scale, Unit = 1,000,000,000 Galls
Year.
Water Rental.
Water Consumption in Thousand Millions of Galls.
Probable Rental if the Reductions of 1881, 1883 and 1884 had not taken place.
Probable Rental, £160,000
Water Rental on the Three Rentals of 1890
Planned works to be opened for supply of Birmingham
Ithon
Tame
Severn
Elan
Claerwen
Wye
Perry
Whitacre
Whitacre Pumping & Engines Wells purchased by Corporation
Saltley Gas Well opened
Aston Engines, Whitacre Wells Gone Dry, Severn Water

Fig. 1. Diagram of Water Supply and Rental.

MANSERGH expects that about 66 ins. is the average over the whole gathering ground. He reckons on collecting at least 40 ins., which on the above area would mean a total annual supply of 36,000,000,000 galls., or just under 100,000,000 galls. per day. Some of this is waste and some must be devoted to compensation, but there ought to remain 80,000,000 galls. per day when the full complement of storage reservoirs is finished.

This district is almost uninhabited. There is one small tin mine on it, this being the only works or factory of any sort. The whole population is about 180 persons, and the land is devoted practically entirely to sheep runs, there being no agricultural farming. It is so remote that it is likely to remain in this condition for perhaps a century or more. The water obtained is therefore absolutely free from sewage contamination. An analysis shows the ammonia to be *nil*, the organic nitrogen to be only 0.017, and the total solid impurity to be 7.78 in 100,000. The hardness is 2.3 grains of lime bicarbonate per gal., and it is described as "almost perfectly clear." It is thus a soft water of very great purity, and it is likely to remain so for an indefinite period. Specimens of the new water have been submitted to various chemical and sanitary experts with special reference to the possible action of lead service pipes upon it, and we are informed that it has been proved not to be acted on at all by lead.

The elevation of the ground runs from 800 ft. to 2,100 ft. above Ordnance datum. Thus, the water would flow by gravity all the 80 miles to the Monument-lane service reservoir in Birmingham, whence it would flow easily to the greater part of the city. Only the high Edgbaston district would still need to be supplied by pumping, and this only through a height of 70 ft. Thus when the new scheme comes into full operation the cost of pumping will be reduced from the present annual sum of $115,000 to $25,000.

The storage reservoirs on the gathering ground will be built from time to time to meet the increasing demand. Mr. RAWLINSON in 1871 suggested 7 sites for these; but this selection cannot be considered final. Mr. MANSERGH proposes one large compensation reservoir, with a capacity of 4,000 million galls. About half way between the Elan and Birmingham a reservoir of 1,000 million galls. is proposed. No exact details can be settled until the whole ground is carefully surveyed.

In the absence of such details only a rough approximation to the cost of the works can at present be given. Mr. MANSERGH thinks that $20,000,000 will cover it. This expenditure would be spread over 10 years, from 1892 to 1902. The present water rental is $650,000, and will have grown to over $700,000 in 1892. In that year it is proposed to increase the water rates to the amount of $120,000, making them $820,000. The accountants employed to make a financial investigation of the scheme reckon that a natural growth of 3% per annum is on the safe side. With the increased rates this will in 1895 produce $900,000; $1,045,000 in 1900; $1,210,000 in 1905; $1,400,000 in 1910, and $1,580,000 in 1914. Allowing 3% interest on capital expenditure, and providing a sinking fund for the full repayment of loans within 68 years of their contraction, the general effect upon the finances of the city water department is expected to be that there will be a surplus of income over expenditure up to the year 1898, when the accumulated surplus would be over $800,000. From that year until 1908, the expenditure would be greater than the income, and the surplus in hand would dwindle, until in 1908 and 1909 there would be a total deficiency. From 1909 onward the excess of income over expenditure would rapidly increase. The resulting accumulated surplus could be spent either in remitting water rate, or else in hastening the complete repayment of the debt, so as to wipe it out before the expiry of the 60 years.

There is only one suggestion that we may venture to make for the improvement of these arrangements. Why not develop more rapidly the full possible water rental obtainable from the scheme by inducing the minor towns on the route to take water from the Birmingham supply? The engagement to supply them need not be a permanent one. Some of these towns are in very great need of a purer water supply, but are not at present strong enough to obtain it independently. They may be better able to do it in the future, either separately or in conjunction with Birmingham, for a still more extended midland supply. In this same district there is plenty more water to be got by extending the area of the gathering grounds to the Wye, the Ithon, and the Tame. When a big undertaking like this is once resolved upon, its rapid development to its complete possible limit conduces to economy in finance.

Notes on Distribution Reservoirs.

A paper with the above title was recently read before the Civil Engineers' Society, of St. Paul by Mr. W. W. CURTIS, of that city, and published in the *Journal of the Association of Engineering Societies* for April, 1891. We abstract the following from the paper:

In speaking of covered reservoirs, Mr. CURTIS cites several authorities to show the good effect produced upon underground waters by covering the reservoirs. This leads, naturally, to the size of reservoirs—a very important question in any case,

and doubly so if the reservoir is to be covered. No general rule can be laid down on this subject, as the size will vary with the mode of supply and other local conditions. The margin of safety should, of course, increase with the interests at stake. The material used in reservoir construction will also vary with local conditions, masonry being almost a necessity if the reservoir is to be covered.

Mr. CURTIS seems to favor the circular form where admissible, and gives as an illustration the plan and section of a reservoir built by him at Monmouth, Ill. This reservoir is circular, 50½ ft. in diameter at the top, 49½ ft. at the bottom, with a wall 20 ft. high. The bottom is covered with 6 ins. of concrete, which is thickened to 18 ins. beneath the wall, the foundation thus formed being 5 ft. wide. The wall is of very hard brick, in cement, with a thickness of 22, 18 and 13 ins. for 9, 6 and 5 ft. in height from the bottom, the last 5ft. being above the surface. Mr. CURTIS states that such brickwork is greatly superior both in impermeability and strength to stone which can be had at reasonable prices, and adds that if stone is used it should be lined with brick with a good thickness of mortar between.

Mr. CURTIS emphasizes the superiority of reservoir walls or embankments of one material, preferring, for instance, to place the concrete which might be used for a breast-wall upon the inner slope, and in case of faulty foundations advocating that the protection against water working beneath the embankment be concentrated at the toe of the inner slope. To obviate slips offsets may be used on the inner slopes. If the bank is of very open material the concrete slope-lining may be backed with puddle, but the same amount of clay incorporated into the first 5 ft. of the bank back of the concrete is considered preferable. If desired, the concrete can be faced with brick to lessen frost or wave action. If frost is feared, the concrete may be carried from a point at or below low water horizontally away from the inner slope, covered with a thin layer of asphalt, above which brick in cement would be laid. The bottom of reservoirs should be covered with concrete or brick; and if the earth is porous, a puddle foundation can be used to good advantage.

Petroleum in the United States.

The statistics presented in Census Bulletin No. 76 show that 34,820,306 barrels of petroleum were produced in 11 states in 1889, valued at $26,554,052. The states from which returns are presented are Pennsylvania, New York, Ohio, West Virginia, Colorado, California, Indiana, Kentucky, Illinois, Kansas and Texas. Of this total production, 109,891 barrels were disposed of for lubricating, 12,330,813 for fuel and 22,379,602 for illuminating purposes. Nearly the entire amount of oil produced in California, Indiana and Ohio was used for fuel; while almost the entire supply from Colorado, New York, Pennsylvania and West Virginia was devoted to illuminating purposes.

Of the total 34,820,306 barrels produced in 1889, 21,486,403 barrels came from the Pennsylvania and New York fields and 12,471,965 barrels were produced in Ohio. Texas only furnished 48 barrels in the above list and Kansas 500 barrels. West Virginia and Colorado are close together with 358,269 and 316,476 barrels respectively. California produced 147,027; Indiana, 32,758; Kentucky, 5,400, and Illinois, 1,460 barrels.

An interesting table is presented of the annual production in the various oil fields since 1859, or the beginning of operations. The total production in the United States between 1859–1889 was 407,985,503 barrels of 42 galls. each. Pennsylvania and New York commenced in the year first named with 2,000 barrels, and the output rose to 500,000 barrels in 1860, and to 2,113,609 in 1861. The production for these two states steadily rose to 6,233,194 barrels in 1872, with 9,893,786 barrels in 1873. In 1874 the oil of Ohio, West Virginia and California came regularly into the market with 200,000, 3,000,000 and 175,000 barrels respectively, these amounts including all production in these states up to that time. Kentucky and Tennessee came in in 1882, with 160,933 barrels; and oil was not produced in Illinois, Kansas and Texas until 1889. The maximum output from the Pennsylvania and New York oil fields was in 1882, or 30,053,500 barrels. In 1881 the production for the same states was 27,376,509 barrels.

The stocks of crude petroleum on hand Dec. 31, 1888 and 1889, in barrels of 42 galls., were as follows:

	1888.	1889.
Pennsylvania and New York	18,995,814	11,562,591
Ohio	10,161,842	14,415,997
Colorado	13,092	36,034
Kansas	240	150
Illinois	110	100
Texas	6	48

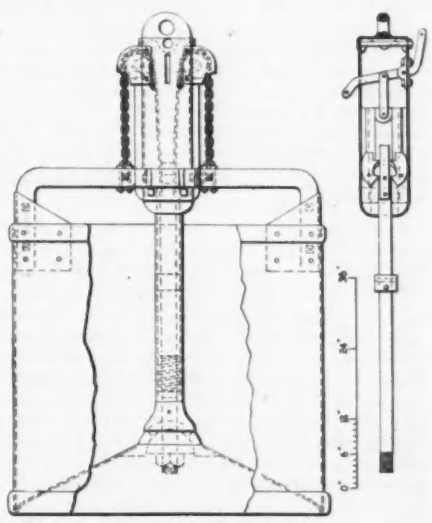
The exports, in gallons, of petroleum and petroleum products for the years 1888, 1889 and 1890 were as follows:

	1888.	1889.	1890.
Crude	77,387,736	83,991,196	95,365,765
Naphtha	13,466,234	13,958,680	12,406,586
Illuminating	431,964,143	548,395,731	547,542,569
Lubricating	24,280,826	27,754,339	31,886,146
Residuum	1,861,104	1,838,694	1,828,900
Total	568,960,103	675,938,540	689,029,966
Value	$37,649,345	$52,793,241	$51 656,677

The Ludlow Coal Bucket.

In dumping coal into vessels with the ordinary turn-over buckets, which drop their load within an area of a few square yards even when discharged from 20 to 30 ft. above the pile, there is often a tendency to let the coal fall from such a height that it becomes badly broken. The Ludlow Mfg. Co., of Toledo, O., has recently introduced an improved bucket that renders such a practice impossible, and also insures a more uniform distribution of the load than was heretofore obtained.

As may be seen from the accompanying cuts, the bucket acts like the bell in the top of a blast furnace.



The Ludlow Coal Bucket.

It has a conical bottom which so scatters the coal that in order to get it into the vessel the bottom must be placed below the deck, thus shortening the distance of the drop to a few feet. The coal slides out instead of being thrown, and is so spread as to practically trim itself in the vessel. The entire load is supported by a round iron rod, 2½ ins. in diameter, which passes through the center of the cone. The catches, and all other lifting parts, are made of cast steel, and are guaranteed to sustain a weight of 10,000 lbs. The shell is of No. 8 steel plate, and the bottom is of ¼-in. steel plate, its conical shape making it stiff enough to sustain heavy loads. It can be tripped from the deck of the vessel or by the engineer of the derrick, as desired.

The side or shell of the bucket is so connected with the bottom by chains and a center rod that it acts like a counterweight. When the bottom drops a foot, the shell rises the same distance, making an opening at the bottom of 2 ft., which is sufficient to discharge the largest lumps. As soon as relieved of the load, the side or shell being heavier than the center rod and the cone, the bucket automatically closes and catches itself ready for another load.

All parts are numbered, interchangeable and easily put together. The bucket has been extensively used in Ohio and is reported to work successfully. It has been recently adopted at Toledo by the Toledo & Ohio Central Ry., and to Mr. CLIFFORD BUXTON, Chief Engineer of that line, we are indebted for the above information.

Slag Bricks.

In the *School of Mines Quarterly* for April, 1891, Dr. THOS. EGLESTON describes a simple and effective process for manufacturing slag bricks, as employed at the Parrott Works, at Butte, Montana. The process was invented by Mr. J. E. GAYLORD, of that company.

Cast-iron molds are used, made up of a separate bed-plate 1½ ins. thick and any numbers of T-shaped pieces with bevelled edges, which are placed alternately as far as the top and bottom of the T are concerned. Each T-piece is 1 in. thick, 14 ins. long, 12 ins. wide on the inside and 14 ins. wide on the outside, and has a projecting lip on top by which it can be removed from the bed-plate by hooks. The bricks are each 12 ins. long by 6 ins. wide and high, and weigh about 55 lbs. They are made by contract for a rate of 85 cts. to $1.00 per hundred, and one man can make 350 in a day.

The molds are arranged in a continuous line between two track-boards resting on low brick piers, with run-boards leading to them. The frames are put together so as to form 5 molds, usually. The slag-pot is run up the incline and two holes are first punched through the crust to permit pouring. The molds are then filled and the shell remaining in the pot is taken to the dump-heap.

By the time the molds in No. 3 plant are full, the attendant is ready to take to pieces the frame of No. 2. He pulls the T-irons out by a hook inserted in the lip mentioned and leaves the hot bricks to cool on the iron pavement. By this time the bricks in No. 1 plant, which has had its frame already removed, are ready to be piled, though still hot. He lifts these up by a shovel and piles them close together, and then reconstructs mold series No. 1 ready for another casting. About 10 minutes elapse between the casting and piling.

These bricks are as hard as stone, but brittle. They are used exclusively in the construction of kilns about the work and last for a long time. A considerable quantity are also sold in the town. They require less mortar than ordinary bricks, as they are less porous. The iron molds last indefinitely if the slag is not permitted to cool in them. In the latter case the cast-iron becomes useless in a short time. The great advantage of the process is that over two-thirds of the slag produced at these works is now a source of profit instead of expense in disposal.

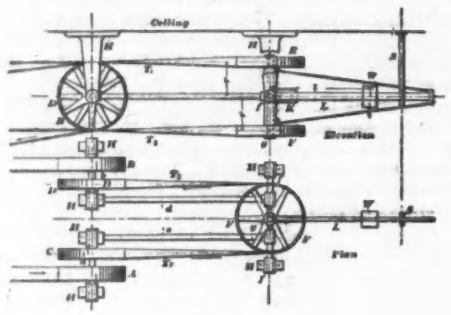
Water-Works of Allahabad, India.

The new water-works have been built according to the plans prepared in 1889 by Mr. A. J. HUGHES, M. Inst. C. E. A daily supply of 2,000,000 galls. is taken from the Jumna River, and flows by gravity through a pipe into the inlet well sunk in the river bank. After the silt has been deposited the water is drawn by pumps situated 150 ft. distant and then forced through 10,000 ft. of pipe to the settling tanks. There are two compound, jet condensing, beam, pumping engines, which are used alternately to fill the tanks.

The river water is pumped into each or any of the settling tanks. These hold about 4 days' supply, or 2,800,000 galls. each, so that the river water can settle for 3 days if necessary, before a floating pipe decants the clear top-water to the sand filters. Analysis has shown that the Jumna water is of such quality that filtration through 30 ins. of fine sand and 6 ins. of coarse sand and pebbles will make it as pure as desired. On leaving the filters, the pure water is stored in an arch-roofed reservoir of brick, which consists of two separate compartments, each having a capacity of 2,250,000 galls. From this reservoir the filtered water is forced to the town by a pair of bucket and plunger pumps, each worked by a compound, surface-condensing, beam engine. Each of these pumps can deliver 3,722 galls. a minute into the mains, or, together, 446,500 galls. an hour, so that the pumping machinery is powerful enough to pump the daily supply in 4½ hours if necessary. Both engine houses will be lit with electric light. The engines are erected in an engine house of a style which is said to be not glaringly incongruous in the Indian garden with its ancient tombs and feathery palm trees. Mr. W. PARRY, A. M. Inst. C. E., was Resident Engineer. The contractors for the works were Walsh, Lovett & Co., of Calcutta, and the pumping engines were built by Easton & Anderson, of London.

A Belt Dynamometer.*

The dynamometer here presented consists of a set of pulleys mounted on a suitable frame and disposed as follows: The pulleys *A* and *C* are fixed to the shaft *a*; *B* and *D* are fixed to the shaft *b*. The pulleys *E* and *F* revolve freely, as independent loose pulleys on the shaft *g*. The shaft *g* has a second shaft, *f*, fixed to it midway between the pulleys *E* and *F*. Shaft *f* constitutes a pivoting axis, parallel to the shafts *a* and *b*, for the shaft *g*, together with the frame *K* and the weight lever *L*, all rigidly connected. Only enough motion of *L* is allowed to determine the direction of action. Instead of the weight on the lever *L*, the end of the lever could be connected to a small platform scale and its tendency to rotate weighed. It might be useful to make the frame between the pulleys adjustable at *d* and *e* in order to vary the tension of the dynamometer belt, or better still it might be so constructed that the absolute tension could be noted at any time whether working or at rest. The working of the apparatus is as follows: A driving belt from the source of power is put on the pulley *A*. The machine to be driven is belted from the pulley *B*. The dynamometer belt passes from the lower side of the pulley *C* to the pulley *F*, around *F* to *D*, around *D* to *E*, around *E* back to *C*. It will be seen that *C* is a driving pulley and *D* a driven pulley. When the system is at rest the four strands of the dynamometer belt have the same tension. If now *C* revolve and drive *D*, the tension T_1 of the belt from *C* around the loose pulley *F* to *D* will correspond to the tension of the



A Belt Dynamometer.

taut side in a simple system of two pulleys, and the tension T_2 of the belt from the lower side of *D* around *F* back to the lower side of *C* will correspond to the slack side.

The difference of tension is the driving pressure *P*, and taking what actually occurs we have

$$\frac{2T_1 - 2T_2}{2} = T_1 - T_2 = P.$$

Now *P* in pounds multiplied by the speed of the belt is foot pounds developed or consumed, ignoring friction. Let *r* be the radius of the position of pulleys *E* and *F* from the pivot *f*. Let *l* be the distance of the weight *W* from *f*, to balance the tendency of the frame K to rotate about *f* when working, then

$$(Wl = r\,(2T_1 - 2T_2) \text{ or } \frac{Wl}{2r} = T_1 - T_2 = P.$$

It is evident that should a Prony brake by put in place of the pulley *B*, the power developed by the motor to *A* could be determined. If a machine be driven from the pulley *B*, the power consumed could also be noted in the speed of belt and the position of the weight from the same formula. In the use of different belts as dynamometer belts the relative efficiency of such belts can readily be determined by the use of the brake attachment. It will also be seen that but one side of the belt comes in contact with the pulleys.

Bituminous Coal in Pennsylvania.

Census Bulletin No. 67 treats of this important industry from material prepared by special agent Mr. JOHN H. JONES. It shows that the total output for 1889 was 36,174,089 short tons, or nearly double that reported in 1880. The total value of this coal is given as $27,953,215, or an average of 77.2 cts. per ton (2,000 lbs.) at the mines. The average value in 1880 was 100.8 cts. The number of persons employed in 1889 was 53,780, against 33,248 in 1880; and the amount paid in wages was $21,142,051, as compared with $10,863,583 ten years ago.

The output for small local banks and farmer's diggings was 820,197 tons in 1889. Of the total quantity mined 4.4%, or 1,590,651 tons, was sold to the local trade or to employés, and 28.17%, or 10,190,588 tons, was manufactured into coke.

During the year 1889 there were in operation 525 regular establishments and 2,949 country banks. Clearfield, Allegheny, Fayette, Westmoreland, Washington and Cambria counties operated 371 out of the 525 regular establishments, in which the sequence given above, in which the first county starts out with 91 mines and the last with 37. Out of the total product of 36,174,089 short tons, 24,059,913 tons were loaded at the mines for shipment by rail or on boats; 1,590,651 tons, were sold to local dealers and employés; 332,937 tons were used for steam and heat at the mines and 10,190,588 tons were made into coke. The larger part of the latter amount, 8,823,899 tons, comes from Fayette and Westmoreland Counties.

*A paper by S. P. WATT, Mech. Engr. Columbus Machine Co., Columbus, O., read at the Providence Meeting of the American Society of Mechanical Engineers.

THE PORTELECTRIC RAILWAY at Dorchester, Mass., was recently examined by Mr. F. L. POPE, who pronounces it a feasible means of transporting mail and other matter at a very high speed. The experimental plant comprises an endless track elevated a few feet above the ground, 2,784 ft. long, and consisting of two tangents of 972 ft., a curve of 282.5 ft. radius and a curve of 234.4 ft. radius. Portions of the line are on grades of 4½%. The track consists of an upper and lower rail formed of bar steel, ¾ × ¼ in., fastened by countersunk screws to stringers. The carrier is virtually a hollow projectile of wrought iron, cylindrical in form, with ogival ends. It is 12 ft. long, 10 ins. in diameter and weighs 500 lbs. It is supported by two wheels on each rail. The propelling power is derived from a series of hollow helices of insulated copper wire, each of which encircles the track and carrier. They are fixed along the permanent way at intervals of 6 ft. The upper rail carries the current, which is switched into each helix by a contact wheel on the carrier when the latter enters the helix. In this way the car is drawn along by magnetic attaction, just as the striking bar of an electric drill is pulled up and down by the action of the solenoids surrounding it. During the trials conducted by Mr. POPE, the highest speed obtained was 33.5 miles an hour. This is believed to be far below the capacity of the system when provided with improved appliances and run on a better track.

A LONG PIPE LINE composed of Mannesmann tubes was completed last April in the southern part of the Ural Mountains, near the Caspian Sea. It is used to convey petroleum and petroleum refuse from the nearest storage depot to the copper smelters of Siemens & Halske, at Kedabeg. The line is over 15½ miles long and is subjected to a pressure of 100 atmospheres in its lowest parts. The steel pipes employed are 4.02 in. in inside diameter and 0.217 in. thick. They are joined by sleeves screwed over the connecting ends of the pipes, and every part liable to give way was tested under a pressure of 200 atmospheres at the Mannesmann works at Komotau.

THE SUIT OF THE EDISON ELECTRIC CO. VS. THE WEST END STREET RAILWAY CO., of Boston, for alleged infringement of patents, will be defended by the Thomson-Houston Electric Co., says a Boston item.

THE GULF STREAM is to be further studied by the U. S. Fish Commission, with Prof. LIBBEY, of Princeton, in charge. The first point to be investigated is south of Nantucket, and the principal object of the expedition will be to determine the isothermal lines and the influence of meteorological conditions on these lines, with a view of studying their effects upon the migration of food fishes.

AN IRRIGATION CONVENTION, to be held at Salt Lake City, Sept. 15 and 17, has been called by Gov. A. L. THOMAS of Utah. Each state and territory interested in irrigation is invited to send 30 delegates at large. The various commercial, agricultural and mechanical associations and each municipal corporation in the states and territories west of the Missouri River are also requested to send delegates to the convention. The convention will consider matters pertaining to the reclamation of arid public lands and the petitioning of Congress to cede to each state and territory the arid lands within its boundaries.

A CONCRETE-BLOCK LINING is to be put into the 6 ft. sewer tunnel now under construction in Seattle, Washington. Mr. ALBRO GARDNER, the city engineer, writes that these blocks will be 8 ins. thick, 12 ins. wide and 24 ins. long. The shaft now being sunk is 60 ft. deep, and is made of concrete blocks 12 × 12 × 24 ins., started on a wooden shoe. The shaft is now down 45 ft., and is a success so far. The use of concrete in this form is somewhat novel, and Mr. GARDNER'S experiments will be watched with interest. The excessive cost of brick in that city is the chief incentive for the application of concrete.

THE PANAMA CANAL, and the proposed prosecution of its management, are prominent topics in London and Paris. The correspondent of the *London Times* looks upon the decision to prosecute as a weak measure which will complete the ruin of the enterprise. Another report says that the measures to be taken against Mr. de LESSEPS and his friends is part of the scheme of a credit foncier syndicate which wants to finish the work. Mr. BONAPARTE WYSE sees no useful purpose in the prosecution, and said that though the accounts showed irregularities nothing indictable had yet been brought to light.

A 16-IN. ARMY GUN is to be at once commenced, by order of the Secretary of War. This gun will be 49½ ft. long, weigh 125 tons, use a charge of about 1,000 lbs. of powder, and send a projectile weighing one ton 15 miles. The muzzle penetration in iron would be about 3 ft. Of these guns only 44 are included in the plans of the Fortification Board, 36 of them to be placed in the harbors of New York, San Francisco and Boston. The new 12-in. gun made for the Navy is to supplant the 16-in. gun proposed for several of the new battle ships.

AN ACT RESTRICTING THE HEIGHT OF BUILDINGS IN CITIES was approved in the Massachusetts Legislature on May 21. By the terms of this act no building more than 150 ft. in height above the grade of the street shall hereafter be erected. This restriction, however, does not apply to grain or coal elevators, sugar refineries, steeples, domes, towers or cupolas erected for strictly ornamental purposes of fire-proof material.

THE ENGLISH POSTMASTER-GENERAL is having some awkward questions put to him by the House of Commons regarding the sending of mails to America. The fight is practically between the White Star and the Inman lines of steamers, the latter being a non-contract line. It so happens that every alternate Thursday the *Germanic* or *Britannic*, of the first named line, carry the mails out of Queenstown on the same days that the *City of New York* or *City of Paris* leave without mails. The average time of these White Star steamers is about 8½ days, while the faster Inman steamers make the passage in about 6 days. The business community are objecting to this discrimination through Parliament.

LIGNITE FUEL, prepared according to the invention of a Signor SAPORI, is said by the London *Standard* to have been successfully tested in Rome. A train was run with it using 367 kilos. of the new fuel as against 300 kilos. of coal. The service was "equally good" with either combustible. This is an important item, if true, and if the lignite fuel is commercially useful. There are large and rich deposits of lignite in Italy, and also in Costa Rica and other of the Central American states, where ordinary coal is so costly as to permit considerable expense of preparation in the lignite fuel. No details are yet given of Signor SAPORI'S method of conversion, the weight and volume of the fuel, etc.

THE BANGKOK-KORAT RY., in Siam, is open for tenders for construction and equipment, says the English Minister at Bangkok. The line would be 164 miles long.

THE OMNIBUSES AND TRAMWAYS OF PARIS carried, in the year 1889, 214,296,940 passengers, an increase of 22,079,683 passengers over 1888. The Exposition of 1889, of course, accounted for much of this gain in travel. On Jan. 1, 1890, La Compagnie Generale des Omnibus owned 13,485 horses and 911 vehicles of all types. Of this number 275 were omnibuses with 40 *places* or seats, and 258 ran on tramways. Of the total of 214,296,940 passengers in 1889 58% rode in the interior of the vehicle, and the remainder rode on top for a cheaper fare. The grand total of receipts for fares was 30,744,111 francs ($6,148,822). This is divided, in a report given in *Le Genie Civil*, as follows: Average, $23 per trip of vehicle; $1.60 per trip per horse; 3.72 cts. per passenger. The total receipts from all sources, including sales of manure, special locations, advertising placards, rentals, etc.,

is 43,043,916 francs ($8,788,789). The total expenses in 1889 were 38,781,641 francs ($7,756,329); the net profit was thus $1,032,455; about $3 per day's work of a vehicle, or 20 cts. per day's work of a horse. The expenses were divided as follows, in francs:

Administration and general expenses	3,631,155 fr.
Inspection, traffic, and service of passengers	7,655,603 "
Rolling stock	3,437,885 "
Horses and forage	20,191,560 "
State interest and fixed charges	3,963,406 "
Total	38,781,641 "

THE CABLE ROUTE TO HONOLULU is to be sounded by the S. S. *Thetis*. The U. S. S. *Tuscarora*, 15 years ago, sounded over an earlier proposed telegraph line and developed a shoal, or submarine mountain, in lat. 33° north, longitude 132° 30' west, where the soundings shoaled rapidly from 2,282 fathoms to 388 fathoms. The *Thetis* will seek a line to the north of this point. To avoid missing marked elevations of the bottom of the sea, the *Thetis* will sound at alternate intervals of 10 and 2 miles, unless a shoal is found. This is in accordance with a system devised by Lieut.-Commander R. CLOVER, Hydrographer of the Navy Department.

A PLUMMET FOR USE IN DEEP SHAFTS is described in the June *Lehigh Quarterly*. It is the one employed by the Lehigh Valley Co., and consists of a vertical core 12 ins. long, with 8 radiating flanges, 9 ins. high by 3 ins. wide, of ¼ in. metal. At the bottom there is a circular disk acting as a web. This bob weighs 20 lbs. and has a surface area of about 630 sq. ins. An ordinary bob of equal weight would have a surface of 90 sq. ins. In an ordinary dry shaft 500 ft. deep this form of plumb-bob will settle, under usual conditions, in about one hour, instead of in 5 or 6 hours, as with the older form.

IRRIGATION IN AUSTRALIA is a success, at least in the irrigation colonies on the River Murray, founded about 3 years ago. According to *Engineering*, 11,000 acres of land are being brought under cultivation. Grapes, apricots, figs, oranges and lemons are in bearing. Zante currant vines are thriving and those planted 3 years ago are heavy with fruit. For land planted only 12 months ago offers of $385 to $500 per acre have been refused. The main irrigation channels are now 90 miles long and the subsidiary channels extend 140 miles. The company has expended, at Mildura alone, $1,130,000. The death-rate at this town in 1890 was only 4.4 per 1,000.

AN EXHAUSTIVE ARMOR TEST is soon to take place at the new naval ordnance proving grounds, at Indian Head, on the Potomac River. Plates, 8 ft. by 6 ft. and 10½ ins. thick, are now being prepared by Carnegie, Phipps & Co., of Pittsburg. These plates will represent steel, steel with nickel alloy, steel treated by the Harvey carbonizing process, and nickel-steel treated by the same. Six and eight-inch American made guns will be used, and American made projectiles will be furnished by the Carpenter Steel Co., which manufactures these after the Firminy system. This trial of American made material, all around, is one of unprecedented importance, to this country, at least.

RUSSIAN ARMOR-PLATE TESTS at St. Petersburg are reported by Capt. G. J. F. Talbot, R. A., in the current number of the Proceedings of the Royal Institution. The three plates tested were (1) a compound plate by Brown, (2) Schneider steel plate, said to contain nickel, (3) a steel plate by Vickers. These plates were 10 ins. thick and 8×8 ft. in surface dimensions. Each plate was adjusted to a frame made to represent the sides of a vessel and they were backed by 12 ins. of pine. The gun used was 6 ins. caliber, 35 calibers long, firing Holtzer steel shells, weighing 90 Russian pounds. The first shot cracked the Brown plate, the second contributed several more cracks, and the third, fourth, and fifth projectiles passed clean through the plate, the backbacking and the iron structure. They were found intact 900 yds. behind the plate. On the whole, the Brown plate showed very poor resistance. The first shot at the Schneider plate rebounded after penetrating 9 ins. The second projectile penetrated 8⅝ ins. and broke up. The third, fourth, and fifth shells penetrated 11.5 ins., 9½ ins., and 11 ins. respectively, but did not pass through. This plate presented great resistance, but a large number of cracks appeared, and these the board pronounced of a very bad character. The Vickers plate showed an excellent appearance all through the trial. The only real cracks on the plate were those left after the second shot at the right top corner. In the case of the Brown and Schneider plates it was necessary to bolt them together in a frame in order to get photographs of their backs, but this was not necessary in the case of the Vickers. The Russian Government has given large orders for Vickers armor plate, evidently thinking that that plate won at the trial. This trial is interesting, as coming to somewhat different conclusions from those arrived at from the late tests at Annapolis. At the latter trial the nickel armor came out ahead.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Philadelphia & Reading.—The Tamaqua, Hazleton & Northern R. R. being built by this company from Lofty, Pa., to a connection with the Delaware, Susquehanna & Schuylkill R. R., 12 miles, will cost about $400,000.

Phillips & Rangeley.—This railway from Phillips to Rangeley, Me., 27 miles, has been opened for passenger traffic. Four miles of the line were constructed this year and the remainder in 1890.

Projects and Surveys.

Plymouth & Middleboro.—The Old Colony R. R. Co. has signed the agreement to operate this road for 30% of the receipts when completed. The road is projected to run from Plymouth to Middleboro, 16 miles, and it is expected that construction will be begun soon.

Lehigh & Western.—A charter has been granted this company to build a road from Berwick to White Haven, 35 miles, to connect the Wilkesbarre & Western and the Lehigh Valley.

Westerly & Jewett City.—There is a probability that construction may begin on this proposed railway from Westerly, Conn., to Jewett City, R. I., 25 miles, this season. A considerable amount of the stock has been subscribed.

Exeter & Amesbury.—There is a prospect that work will soon begin on this New Hampshire railway, as the Concord & Maine R. R. Co. has made an offer to aid in its construction on the condition that a favorable route can be secured. The road is projected to run from Exeter to Amesbury, N. H., 12 miles. J. J. Bell, Exeter, N. H., President.

Washington County.—It is stated that the right of way for this proposed railway from Greenwich, N. Y., to Rutland, Vt., 56 miles, has been secured.

Wiarton Southern Railway.—Messrs. McLennan, Stuart & Chapman, civil engineers, of Toronto, Ont., write us as follows:

Mr. Stuart, of this firm, has recently completed a preliminary survey of this railway from Wiarton, Ont., to Rockford, on the Owen Sound branch of the Canadian Pacific Ry. The distance is about 20 miles, and the line will open up a fine lumbering and farming country. Wiarton possesses a magnificent natural harbor, and must eventually become one of the chief shipping points on Georgian Bay. The promotors expect to receive aid from the Government and municipalities, and if successful will commence construction at an early date. Mr. John Irwin, of Wiarton, Ont., is President.

SOUTHERN.—Existing Roads

Charleston, Sumter & Northern.—Tracklaying has been completed from Bennettsville to within 2½ miles of the Pee Dee River. The work from Darlington, S. C., north toward the river is also making good progress. Surveys are in progress from Bennettsville to Hamlet, where connection is made with the Carolina Central.

Atlantic Coast Line.—Tracklaying has been commenced on the Wilson & Fayetteville R. R., at Fayetteville, N. C. The road will run from Fayetteville to Rowland, N. C., 40 miles.

Blackville, Alston & Newberry.—About 500 men and 250 teams are now at work on the extension from Barnwell to Allendale, N. C., 17 miles. It is expected to have the line in operation by Aug. 1.

Carolina, Knoxville & Western.—The United States Court has granted the receiver of this road authority to issue $10,000 of receiver's certificates to supply funds for completing the short extension north from Greenville, S. C., from its present terminus to Marietta, S. C., 3 miles.

Projects and Surveys.

Mexican Gulf, Pacific & Puget Sound.—S. N. Van Praag, President, is reported as saying that the contract has been let for building 220 miles of this projected road.

Carolina, Greenville & Northern.—The general contract for building this railway from Estellville, Va., to Hot Springs, N. C., 83 miles, has been let to the Southern Construction Co. R. A. Bowie, Greenville, Tenn., Chief Engineer.

Johnson City & Greensboro.—It is reported that the surveys for this railway have been begun by A. N. Molesworth. The road is projected to run from Allentown, Tenn., to Lenoir, N. C., 50 miles. F. A. Stratton, Johnson City, Tenn., President.

Arbuckle Creek & New River R. R. Co.—Chartered in West Virginia; capital $150,000.

Lake City & Albion.—The Legislature has passed a bill incorporating this road.

Tredegar Mineral.—This road has filed articles of incorporation; capital, $50,000. W. H. Forney, James Crook and others, of Jacksonville, are incorporators.

NORTHWEST.—Existing Roads.

Duluth & Winnipeg.—The Itasca Lumber Co. has commenced work on a railway 30 miles long, from Grand Rapids, Minn., north to timber lands. It will be operated by the Duluth & Winnipeg Construction Co.

Canadian Pacific.—Grading is to begin at once on the branch from Melita, Man., to the Souris coal fields. The contractor's plants are now being shipped, and preparations are being made to vigorously push work.

Projects and Surveys.

Sioux City, Madison & Northern.—Chas. B. Kennedy, Madison, S. Dak., President, writes as follows:

This road is projected to run from Garretson, S. Dak., via Madison to Minot, N. Dak., 440 miles. Surveys have been finished from Garretson to Madison, 30 miles. The road is through a rolling prairie country affording light work; maximum grade, 1%, and maximum curve, 8°. The company was chartered April 23, 1891. E. D. Vincent, of Sioux City, Ia., is Chief Engineer.

Storey City, Fort Dodge & Sioux Falls.—A company will probably soon be chartered to build a railway from Storey City, Ia., to Sioux Falls, S. Dak.

SOUTHWEST.—Existing Roads.

Kansas City, Watkins & Gulf.—Surveys are being made for an extension of this railway north of Alexandria, La., for 50 miles across the Red River to a point in Winn Parish. It is not proposed to construct any of this extension this season. The construction south of Alexandria is easy, though it has been greatly retarded by the high water this spring. The track has been laid for 30 miles north of Lake Charles, 14 miles of it this year, and 300 men and 100 teams are now at work. It is expected to finish the road to Alexandria by Sept. 1.

Kansas City, Nevada & Fort Smith.—Contracts will soon be let for additional sections of the proposed extension of this railway. The road is now under construction from Amoret, Mo., to Hume.

Missouri Pacific.—The mortgage bonds of the Fort Scott & Eastern Ry. Co. have been filed in Missouri. The bonds are for $15,000 per mile and are for construction alone. The road is to run from Ft. Scott, Kan., east to Tifton, Mo. The section from Fort Scott, Kan., to Rich Hill, Mo., is already finished.

Projects and Surveys.

Paris, Choctaw & Little Rock.—It is rumored that steps are being taken to commence work on this railway from Paris Tex., to Hot Springs, Ark. S. J. Wright, Paris, Tex., President.

Red River & Chiachita Timber Belt.—Chartered in Louisiana to build a railway from a point on the Red River, in Bossier Parish, La., northwest to the Arkansas line. Among the incorporators are F. M. Hanks, J. W. Whittington and others.

Salt Lake, Colorado & Gulf.—Chartered at Salt Lake City, Utah, and proposes to build a road from El Paso to Galveston.

ROCKY MT. AND PACIFIC.—Existing Roads.

Northern Pacific.—About 1,500 men will soon be put at work on the line from Chehalis to South Bend, Wash.

Oregonian.—Tracklaying has been begun on the line from Coburg to Jasper, Ore. It is expected to lay 1 mile of track per day and to have the extension finished within 10 days.

Los Angeles Terminal.—A shipment of 1,000 tons of steel rails is now on the way to Los Angeles. The rails are to be used on the Los Angeles Terminal Ry. It is intended to begin tracklaying at once, and to have the line to Long Beach in operation by Aug. 1.

California & Nevada.—Grading has been completed on the 9-mile extension from Orinda Park to Walnut Cove, Cal., and tracklaying will soon begin. It is expected to have the extension completed by August.

Silver City & Northern.—About 12 miles of track have been laid on this line from Whitewater to Georgetown, 24 miles. The road will ultimately be extended to Mimbres, N. Mex., 18 miles further.

Pajaro Valley.—The contract for building the extension of this railway from Moro Cajo to Salinas, Cal., has been let to B. McMahon & Son.

Rio Grande Western.—Twelve miles of track have been laid on the Sevire Ry., from Manti, Utah, toward Salina, and work is in progress on the remaining 10 miles.

Projects and Surveys.

Siuslaw & Eastern Ry. & Navigation Co.—A. G. Harvey, of Eugene, Ore., Vice President, writes us as follows:

The locating surveys are nearly finished for the line. It is projected to run from Eugene, Ore., to Florence, Ore., on the Siuslaw River, and thence to Coos Bay. There will be one small tunnel. Nearly all of the right of way has been secured. The principal business will be in timber, coal, building stone and general merchandise. The contracts for construction will be let soon. Geo. H. Ellsburg is President.

Clysterville Railway, Land and Improvement Company.—A. G. Hardesty, Astoria, Ore., General Manager, writes as follows:

The surveys have been completed and the grade stakes set for this railway from Seaside, Ore., through Clyster-

ville to deep water at Stackpole Harbor, a distance of 6¼ miles. The line when completed will be 36½ miles long. The route is through a level country and the work will be generally light. The object of the road is to develop the summer tourist travel to the sea coast. All of the right of way has been obtained and a considerable local aid has been secured. The company was chartered Nov. 12, 1890. Geo. M. Traver, of Tacoma, Wash., is President.

FOREIGN.

Chamela & Aguascalientes.—The concessions for a railway line from Aguascalientes to Chamela on the Pacific, via Guadalajara, are reported as taken by London capitalists, through Messrs. Pearson & Sons, City of Mexico.

Matamoras & San Luis Potosi.—It is stated that English capitalists have bought the concession of Gen. Cuellar for a railway between the above points, crossing the Monterey & Mexican Gulf Ry. near Linares.

CITY TRANSIT.

Electric Railways.—New lines are reported as probable in the following places: Kanawha, W. Va., address B. D. Avis; Baltimore, Md., address J. Glenn; Lynchburg, Va., address J. T. Leverier, of Baltimore, Md.; El Paso, Tex.; Omaha, Neb., address D. H. Goodrich; Danville, Ky.; Knoxville, Tenn., address the Knoxville Street R. R. Co.; Indianapolis, Ind., address Albert Baker, Fort Dodge, Ia.; Glens Falls, N. Y.

Lockport, N. Y.—About $15,000 has been subscribed to the Lockport & Olcott Electric R. R. Co., and the directors are said to have decided to begin work on the line very soon; $35,000 more is needed.

Geneva, N. Y.—The Village Trustees have granted a charter for a road on Seneca Lake. A company to construct and operate the line has been organized with O. J. C. Rose as President and E. A. Walton as Secretary.

Baltimore, Md.—The Directors of the Baltimore City Passenger Ry. Co. have voted to try storage battery propulsion on a part of their lines.

Annapolis, Md.—The Annapolis City Council has granted conditional right of way to the Edison Electric Light Co. for a line on several streets, according to the Baltimore *Sun*.

Staunton, Va.—Reeves Cott, of this city, and A. T. Holtzman, of Washington, D. C., have applied for a franchise.

Charleston, W. Va.—The Charleston & Kanawha City Electric Ry. Co. was chartered last week to build a line to Kanawha City, a distance of 2 miles. The road will be for freight and passengers.

Knoxville, Tenn.—The line of the Knoxville Street R. R. Co. will be extended to Arlington, a station on the Fountain Head Ry. A bonus of $8,000 has been raised by residents along the proposed route and Pres. W. G. McAdoo, Jr., is reported as saying that the road will be in operation in 90 days.

Mason City, Ia.—It is reported that work will soon begin on the lines of the Electric Street Ry. Co.

Leadville, Colo.—The proposed line to Evergreen lakes, in which Dr. John Law is interested, will generate its electricity by water-power, the water being conveyed by 8 miles of flumes and ditches.

Santa Barbara, Cal.—Burton, Burt & Co. propose to build a 6½-mile line from this city through Montecito to Hot Spring. The estimated cost, including rolling stock, is $80,500, which sum also includes the cost of a telephone line.

Redwood City, Cal.—The Board of Supervisors have granted Behrend Joost and J. W. Hartzell a franchise for a road from Baden through San Mateo to this place, work costing $50,000 to be done the first year and cars to be running within 3 years.

Cable Railway.—*Baltimore, Md.*—It is reported that the Baltimore Traction Co. will begin work at an early date on its Gilmor and Carey St. cable lines.

Horse Railways.—*Uniontown, Pa.*—The directors of the street railway have voted to extend their line.

Towson, Md.—The Baltimore Union Passenger Ry. Co. has bought franchises for a line from Baltimore to this place from the Baltimore & Yorktown Turnpike Co. and the Baltimore & Hampden Passenger Ry. Co.

Salem, Va.—The Town Council has decided to grant a street railway franchise to the party offering the best inducements. The Salem Street Ry. Co., J. S. Leverier, of Lynchburg, and G. L. Colgate, of Bedford, are applicants.

Fort White, Fla.—The Jacksonville-Santa Fé Hard Phosphate Co. is building a line from this place to its mines in Alachua County, and will probably need steel rails shortly.

Tyler, Tex.—T. R. Bonner & Co. will extend their tram line about 2 miles.

Dummy Railways are reported as probable between Whatcom, Lynden and Blaine, Wash., and at El Paso, Tex.

Waterloo, S. C.—J. T. Harris will, it is said, build a line from this place to Cross Hill, on the Georgia, Carolina & Northern Ry. It is estimated that the line will be 5 miles long and cost $18,000.

Berkeley, Cal.—The Hoskins Traction Co., of San Francisco, has applied for right of way over several streets in this city.

New Companies.—Central Street Ry. Co., Santa Rosa, Cal.; capital stock, $25,000. Santa Cruz, Garfield Park & Capitola Electric Ry., Santa Cruz, Cal.; capital stock, $100,000. Murphysboro (Ill.) Street Ry. Co.; capital stock $25,000. Lincoln (Neb.) Electric Ry. Co.; capital stock, $200,000. Alexandria Bay Electric Light & Power Co., Alexandria, N. Y; capital stock, $7,500. Trumbell Electric R. R. Co., Cleveland, O.; capital stock, $150,000.

HIGHWAYS.

New Jersey.—A law has been passed authorizing the governing body of any town, borough or village or of any municipality governed by a board of commissioners or improvement commission, whenever authorized by a majority of the votes cast at an election held for the purpose, to expend such sum as may be authorized by such vote, not exceeding $60,000, for the purpose of paying the costs and expenses of improving the roads, streets and highways within such municipality in such manner as they may deem advisable, and to issue such bonds therefor in the corporate name of such municipality.

Washington.—Thirteen roads are to be surveyed in Snohomish Co. Three viewers will be appointed for each road and the County Commissioners will dedicate the roads upon the reports of the viewers and County Surveyor, which will be submitted by Aug. 1. Mr. Ashley is County Commissioner. Chehalis Co. has voted to issue bonds for $329,000 for wagon roads.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*Newark Bay, N. J.*—It is stated that the War Department has approved plans for a bridge across the bay, to be built by the Jersey City, Newark & Western Ry. Co. for the Lehigh Valley & Pennsylvania R. R. Co. The bridge is to have 2 draws, each 100 ft. in the clear, 8 ft. 5¾ ins. above mean high water. For some time there has been opposition to this project, owing to the low level of the bridge.

Richmond, Va.—The mayor has signed an ordinance granting the privilege to build an iron viaduct on North First St. to connect with Boston Heights.

St. Louis, Mo.—A sum will be included in the general appropriation bill for a new bridge at Twelfth St., over the Union Depot yards. Plans for a structure to cost about $150,000 have been made by Engineer Geyler.

Tunnels.—*Niagara Falls, N. Y.*—It is reported that the Cataract Construction Co.'s tunnel will be lined with brick, contrary to the original plans. G. B. Burbank is Resident Consulting Engineer.

WATER-WORKS.

NEW ENGLAND.

Auburn, Me.—Mayor Savage, Alderman W. G. Lowell and T. E. Eustis, and others, have been appointed a committee to take the necessary action in determining the price to be paid by the city for the property of the Auburn Aqueduct Co., under an act passed this year. The Council has voted to give the company notice of its intention to purchase.

Freeport, Me.—It is reported that a contract for works has been made.

Goffstown, N. H.—The contract for pipe-laying has been awarded to Bartlett, Gay & Young, Manchester. Samuel Upton, Commissioner, informs us that the supply will by by gravity from a mountain stream and that the works are estimated to cost $40,000.

Milford, N. H.—June 20 the town offered for sale $65,000 water bonds, the proceeds to be used to pay for the works purchased some time since from a company.

Whitefield, N. H.—Plans for works have been made.

Boston, Mass.—The Council has requested the Water Board to erect a high service water tower on or near the reservoir in Ward 1.

Haverhill, Mass.—The council will vote July 2 on the taking of property of the Haverhill Aqueduct Co., and the authorizing of the Mayor to apply to the Supreme Judicial Court for the appointment of the commissioners to appraise the property. The Council has instructed the committee on water supply to see if a fair price can be agreed upon between the company and the city.

Lawrence, Mass.—A lengthy petition has been presented to the Aldermen asking for the appointment of a commission to investigate and report upon a new water supply.

South Hadley Falls, Mass.—Improvements to the Buttery Brook Reservoir are projected.

Manville, R. I.—J. T. Richards and E. R. Hadley are on a committee to arrange with Woonsocket for the extension of mains to this place. Legislative authority has been secured by Manville.

Westerly, R. I.—The Council has notified the Westerly Water-Works Co. that the town desires to buy the company's works.

East Hartford, Conn.—There is a move in favor of contracting with the East Hartford Water Co. for a supply. The company has been organized for some time.

MIDDLE.

Albany, N. Y.—Bids are wanted until June 29 for clearing the flow ground covered by the reservoir on the Black River above Forestport. Address Edward Hannon, Superintendent Public Works.

Amenia, N. Y.—The following is from C. Walsh, Secretary:

Contracts for works will be let by the Amenia Water Co., on July 1; estimated cost, $10,000. The supply will be by gravity from springs and a stream. Population, 600.

Buffalo, N. Y.—Bids are wanted by the Water Commissioners for work on the Bird Island Inlet Pier. The contract for completing the new reservoir has been legally transferred from O'Brien & Clark to Dwyer & Huntington, after considerable delay.

Hermon, N. Y.—It is reported that the new works will cost $8,600.

Rochester, N. Y.—The additional water supply committee of the Council has recommended the construction of a conduit for an additional supply from Hemlock Lake, and the local papers seem confident that the supply will be introduced.

Woodbury, N. J.—A $2,500 pump will be added.

Homestead, Pa.—Contracts for works have been let as follows: For reservoir, pumping station and pipe-laying, J. H. Harlow & Co., Pittsburg, at $19,847, $17,500 and $2,985, respectively; for pumping machinery, Wilson & Snyder Manufacturing Co., $8,100.

Philadelphia, Pa.—The Reading R. R. Co., through President McLeod, has made a proposition to the Councils to supply the city with water taken from the Schuylkill above Norristown and brought to the city by means of an aqueduct. The plan includes the utilization of the storage reservoirs of the Schuylkill Navigation Co. The question has been referred to the water committee of the Councils.

Elkton, Md.—Jesse and Joseph Young, of Philadelphia; W. T. Warburton and R. C. Levis, of Elkton, and others, have signed articles for the incorporation of the Elkton Water Co.; capital, $30,000. Mr. Warburton has been elected President and Mr. Levis Treasurer.

SOUTHERN.

Danville, Va.—The banks of the new reservoir are being raised 5 ft.

Petersburg, Va.—The Petersburg South Side Addition Land Co. has been incorporated to do real-estate business and build water-works; capital, $200,000.

Shenandoah, Va.—The Shenandoah Water Co. has been incorporated; capital, $100,000.

Rock Hill, S. C.—The following is from the City Treasurer:

W. B. Wilson, Jr., and B. N. Craig have been appointed as a water-works investigating committee. City works estimated to cost $4,000 to $50,000 are projected. Population, 4,000.

Bridgeport, Ala.—Extensions and improvements are being made, with W. H. Brundige in charge.

Wrightsville, Ga.—An election to vote on $5,000 of bonds for works will be held July 10.

Leroy, Fla.—A water company is projected. Address M. J. Toland.

Palatka, Fla.—It is reported that the stand-pipe capacity must soon be increased.

Bessemer, Ala.—It is reported that the company has enlarged its reservoir and is putting in filters.

New Orleans, La.—There is a scarcity of water here, owing to drought. A supply from artesian wells has been proposed for the "rear" of the city.

NORTH CENTRAL.

North Baltimore, O.—The people have voted 447 to 15 in favor of private works. A yearly hydrant rental of $3,000 will be paid. W. S. Coon & Son, Upper Sandusky, O., who have the franchise, have sent the following additional information:

The supply will be from Portage reservoir, filtered to a reservoir, then pumped to a stand-pipe. The North Baltimore Water Co. will be organized. Estimated cost, $60,000. Population, 4,000.

Van Wert, O.—The Boughen Engineering Co., of Cincinnati, O., is erecting a new brick and stone pumping station.

Franklin, Ind.—A new 2,000,000-gall. pumping plant is being erected by the Boughen Engineering Co., of Cincinnati, O.

Fowlerville, Mich.—The sum of $40,000 has been voted for works.

Grand Rapids, Mich.—On June 30 the people will vote on the issuance of $300,000 of bonds for water-works improvements, including Cook wells and mains.

Mason, Mich.—A vote on the building of $35,000 works will be taken.

Romeo, Mich.—B. N. Seaman, Village Clerk, informs us that a vote for or against works will probably be taken in July. The supply will be from artesian wells. Population, 1,800.

Chillicothe, Ill.—The Chillicothe Water, Electric Light & Power Co. has been incorporated; capital, $50,000. It is reported that J. F. King is Contractor. J. E. Scarry is City Clerk.

Paw Paw, Ill.—Works are talked of.

Waupaca, Wis.—R. N. Roberts has been granted a franchise for works estimated to cost $50,000.

NORTHWESTERN.

Perry, Ia.—The contract for works has been awarded an Omaha firm at $12,900.

Sheldon, Ia.—A water-works election will be held.

Washington, Ia.—Geo. W. Wynn, Cedar Rapids, informs us that he is making plans for works estimated to cost $25,000. Water will be pumped from an artesian wel to a stand pipe, and about 3½ miles of mains will be laid.

West Union, Ia.—Frank Hobson informs us that a water-works election will be held June 29.

Madelea, Minn.—Bonds to the amount of $9,000 have been voted for works. A well has been sunk and a tower will be built.

Stillwater, Minn.—It is reported that a 1,000,000-gall. pump will be added.

Worthington, Minn.—Harrison & Hawley have the contract for works; price, $16,000. The works are to be completed by Oct. 1.

Parsons, Kan.—L. J. Beagle is one of the directors of a company recently incorporated to build works here. An application for a franchise will be made. The Parsons Water Co. built works in 1883.

Beatrice, Neb.—An election has been called to vote $10,000 of bonds for a new supply well.

Broken Bow, Neb.—An election will be held to vote on the purchase by the town of the company's works.

Huron, S. Dak.—It is reported that several miles of new mains will be laid.

Phillipsburg, Mont.—Works estimated to cost $30,000 are under construction by James K. Pardee and others.

Walkerville, Mont.—Both the Butte City Water Co. and a resident have made a proposition for a supply. A supply is now furnished by the Moulton Co.

SOUTHWESTERN.

Albany, Mo.—Bonds to the amount of $19,000 have been voted, 288 to 17, for water-works and electric lights. Address J. W. Witten or Wallace Hubbard.

Kansas City, Mo.—It is stated that surveys will at once be made for the proposed city works.

Baird, Tex.—Efforts to induce a company to build works are being made.

Bessemer, Col.—W. P. Davis and Thomas Russell are on a committee to investigate works. A supply from artesian wells is projected.

Georgetown, Col.—We are informed that the city has agreed to buy the company's works for $27,000.

South Denver, Col.—A new 80-HP. engine is under consideration.

PACIFIC.

Anacortes, Wash.—The Anacortes Water Company has been incorporated by J. C. Smith, J. C. Haines and others; capital, $100 000.

Dayton, Wash.—The contract for works has been awarded to G. H. Sutherland, Walla Walla, for $20,000. The supply will be by gravity from Touchet River, three miles from town.

Whatcom, Wash.—Mayor Jenkins advises the purchase by the city of the private waterworks.

Portland, Ore.—It is reported that the city will extend its mains to the Heights, and that the residents of that section are negotiating with the cable road company to secure power for pumping.

Berkeley, Cal.—Carey T. Morgan and others have applied for a franchise for water-works and electric lights. The proposed supply is by gravity from a large storage reservoir, and Lorin, Golden Gate and other places are included in the scheme.

Los Gatos, Cal.—The Los Gatos Spring Cold Water Co. has a capital stock of $60.000. G. F. Fife, J. L. Boone and others, of San Francisco, are directors.

San Diego, Cal.—John P. Burt informs us that the city has leased for 20 years the works of the San Diego Water Co., including a daily supply of 3,000,000 galls.

Ogden, Utah.—The company has let the contract for excavating for a 7.000,000-gall. distributing reservoir to Wm. Garland for $7,000.

CANADA.

Georgetown, Ont.—G. S. Goodwillie informs us that the town will probably let contracts for works Aug. 1; estimated cost, $40,000. Population. 1,800.

ARTESIAN WELLS.

Pottstown, Pa.—The Pottstown Iron Co. is arranging to have wells sunk at all its mills.

Elizabeth, Pa.—A well will be sunk for the Crystal Ice Co.

Vassar, Mich.—Wells will be added for the water supply.

Texas.—Wells are projected by the Natatorium Co., Ft. Worth; citizens of Greenville; towns of Moody and Paris.

Springer, N. M.—Wells will be sunk near here by I. Bariana & Son, Cheyenne, Wyo., for D. Dwyer.

North Yakima, Wash.—The Yakima County Commissioners will receive bids until Aug. 4 for continuing the sinking of a well from 500 to 1,000 ft. in depth. The well is in the "Horse Heaven" country.

IRRIGATION.

Casper, Wyo.—A press dispatch from Cheyenne states that a project is being developed at this point for a canal from the Platte, to irrigate 2,000.000 acres, the canal to be 130 miles long. DeForrest Richards, a banker, of Douglas, Wyo., is said to be at the head of the scheme. Two surveys have been made and a third is under way.

Pendleton, Ore.—G. W. Sayles, Engineer for the Blue Mountain Irrigation & Improvement Co., has completed and reported upon surveys for the proposed works. The project is said to include a large storage reservoir on McKay creek, 20 miles above Pendleton, and about 40 miles of ditches.

Oakdale, Cal.—The Oakdale Irrigation Co., it is reported, proposes to organize an irrigation district.

San Bernardino, Cal.—F. C. Finkle informs us that Adolph Wood is Vice-President and General Manager of the Arrowhead Reservoir Co., recently incorporated by Cincinnati capitalists, and that Col. Anderson, of Cincinnati, is Chief Engineer. From the San Bernardino *Times Index* we abstract the following additional information:

The company proposes to build dams to impound water on the north side of the San Bernardino Range of the Sierra Madre Mountains, lying east of the Cajon Pass. From the reservoirs water will be conveyed by flume, tunnel and ditches to irrigate the San Bernardino Valley. A. H. Kœbig, San Bernardino, has been making temporary surveys.

Bliss and Toponis, Cal.—Frank Ribletts, of Albion, has completed surveys for two reservoirs and a canal for the Mullins Canal & Reservoir Co., to be used in irrigating land near the above places. Each reservoir will have a dam 30 ft. high.

New Companies.—Champion Valley Water Power & Irrigation Co., Champion, Neb; $40,000. Wellington Lake & Reservoir Co., Jefferson Co., Col.; $100,000; Charles Wheeler, Thomas Withers and others. Tempas Creek Ditch Co., Rocky Ford, Cal.; $15,000. Felix Land & Water Co., Lincoln, N. M.; $100,000. Rancho del Paso Land Co., San Francisco, Cal.; $1,500,000; dealing in real estate and maintaining canals. Jennings Ditch Co., Visalia, Cal.; $4,000.

SEWERAGE AND MUNICIPAL.

Sewers.—***Massachusetts.***—Boston. An appropriation of $30,000 is to be made for extending the sewerage system to Orient Heights.—Lynn. An act has been passed authorizing the City Council to appoint a sewer commission.—Pittsfield. Mr. E. M. Bowditch, of Boston, is engineer for the new sewers.—Westboro. The new sewers will be built by day work and not by contract.—Worcester. To separate the sewage from Mill Brook, the City Engineer proposes to increase the speed with which sewage is passed through the tanks so as to increase the capacity of the purification plant.—Gardner. About three miles of sewers will be built by Mr. F. L. Allen, of Worcester.—Brookfield. Plans prepared by Mr. A. J. Marble for a system of sewerage have been approved by the Selectmen.

Rhode Island.—Providence. The Sewer Committee recently visited the sewage disposal works at Worcester, Mass.

New York.—Flatbush. Plans for sewers prepared by Mr. Bergen have been approved. The main sewer will be of brick 30 to 78 ins. diameter. The cost is estimated at $175,000 to $200,000. White Plains. The former contractor has resumed work on the unfinished sewers.—Rome. A sewer system is projected. Mr. K S. Putnam is Chamberlain.—Oneida. A Board of Sewer Commissioners has been appointed, and plans prepared by Mr. W. F Randall, Chief Engineer, will be submitted to the State Board of Health, June 22. The question of issuing bonds for construction will be voted on in July.

Pennsylvania.—Wilkes-Barre. A brick sewer 9 ft. in diameter is to be built under Market St.—Reading. An improved sewer system is proposed.—Ludwick. The sewerage question will be voted upon July 21.

Delaware.—Wilmington. The engineer has been directed to advertise for sewers to cost about $57,000.

Ohio.—Ashtabula. The city has advertised for bids for a new sewer system.

Michigan.—Ann Arbor. A special committee and the Board of Public Works are to consider the sewerage question.

Iowa.—Sioux City. A brick sewer 16 ft. in diameter and 1 mile long to Perry Creek is projected, at a cost of $250,000 to $300,000. Mr. C. L. Loweth, of St. Paul, is engineer.—Mason City. A sewerage system is to be built.—Marshalltown. About 2 miles of 24-in. pipe sewer will be put in this season.

Missouri.—Belleville. Prof. J. B. Johnson, of St. Louis, will report upon the proposed sewerage system.

Colorado.—Pueblo. An extension and enlargement of the sewer system are necessary.

California.—Stockton. Work is to be commenced at once on the sewerage system, which will cost $250,000. The sewage will be pumped to a sewage farm.—Sacramento. The sewerage question is under discussion.

Street Work—***Pittsfield, Mass.***—It is proposed to appropriate $4,500 for a 15-ton steam road roller.

New York.—About 35,264 sq. yds. of Sicilian rock asphalt were laid last year by the Sicilian Asphalt Paving Co., and over 48,000 sq. yds. are now being laid.

New Brunswick, N. J.—Brick paving is to be laid on College Ave.

Baltimore, Md.—Pratt St. is to be paved with Belgian blocks at an expense of $48,000.

Detroit, Mich.—Brick paving is to be laid on Lower Jefferson Ave.

Topeka, Kan.—About 15 miles of vitrified brick sidewalk are to be built this season.

Oakland, Cal.—An ordinance has been passed appropriating $19,000 for the Lake Merritt Boulevard, and specifications for the work have been prepared.

Montreal, P. Q.—The contracts for laying about 60,000 sq. yds of asphalt paving this season have been let to the Sicily Asphaltum Paving Co., of Montreal, which lays Sicilian rock asphalt.

Bonds.—Fresno, Cal.: $50,000 municipal bonds. Montgomery, Ala.: $25,000 for streets. Anaheim, Cal.: $150,000 for improvements. Grand Forks, N. Dak.: $50,000 sewer bonds sold to F. R. Fulton and E. S. Rollins & Son. San Joaquin Co., Cal.: $50,000 for county jail; bids received until July 6, by N. Nevin, County Treasurer. Springfield Township, Mich.: $8,000 for road improvements. San Antonio, Tex.: $50,000 for municipal improvements. Warren, O.: $3,000 for sewers; bids opened July 11 by G. H. Quinly, City Clerk. Providence, R. I.: $1,500,000 for sewers, etc.; bids opened June 20. Tacoma, Wash.: $200,000 county bonds awarded to Seymour, Barto & Co., of Tacoma, at $5,100 premium. Mount Vernon, N. Y.: $50,000 for sewers; bids opened July 2 by the Board of Village Trustees.

ELECTRICAL.

Electric Light.—New plants or extensions of existing systems are reported as probable in the following places: Charleston, S. C.; Thompsonville, Conn., address R. Hilditch; Westminster, Md., address C. E. Fink; Haverhill, Mass., address the Haverhill Electric Light Co.

Worcester, Mass.—The Worcester Electric Light Co. will put in two 50-arc light dynamos, and if the Worcester Street Ry. Co. decides to rent power from the lighting company, large additions to the equipment will be necessary.

Shippensburg, Pa.—The Shippensburg Electric Light, Heat & Power Co. has contracted to furnish the town with seventeen 2.000 c. p. arc lamps at $70 per lamp per annum, moon schedule, to 12 o'clock, and as many as necessary of 32 c. p. incandescents at $18 per lamp per annum. The contract is for three years from Oct. 1, 1891.

Cedartown, Ga.—At an election on June 9 it was voted to issue bonds for water-works and electric lights.

Franklin, Ind.—The Franklin Water, Light & Power Co. wants prices on a 70-arc light plant, including engines boilers, etc.

Seymour, Ind.—W. H. Shields has received permission to erect poles and string wires for an incandescent system.

Albany, Mo.—At a recent election it was decided to issue $19,000 of bonds for water-works and electric lights.

Omaha, Neb.—It is reported that the contract for the new municipal plant will be let soon.

Topeka, Kan.—The operating expenses of the municipal lighting plant of 185 arc lamps of 2,000 c. p. from October, 1889, to June, 1891, were as follows, according to City Engineer Lewis Kingman: Hours run, 4,138; tons of coal used, 2.840; cost of coal, $7,410; repairs, $1,795; carbons, $1,615; globes, $134; oil, waste, $406; labor, $9,752; miscellaneous expenses, $655. Total cost, exclusive of interest on original expenditure of $52,000 for plant, was $21,796.51 per month. The coal consumption per horse power per hour was 5.8.

New Companies.—Minneapolis (Minn.) Electric Light & Power Co.; capital stock, $750,000; incorporators, Chas. H. Prior, J. W. Griffin, W. D. Hale and others. Arapahoe Electric Co., Denver, Col.; capital stock, $500,000. Charleston (Ill.), Thomson-Houston Electric Co.; capital stock, $40,000. Miller Electric Danger Signal Co., Portland, Me.; capital stock, $100.000. Citizens' Electric Lighting & Power Co., St. Louis, Mo.; capital stock, $750,000. Wisconsin Gas & Electric Co., Superior, Wis.; capital stock, $250,000. Arapahoe Electric Co., Denver, Col.; capital stock, $500,000; incorporators, E. W. Lowry, W. F. Henderson, J. C. Regan, and others.

PROPOSALS OPEN.

Sewers.—***Baltimore, Md.***—Materials for continuation of Jenkins Run sewer. A. E. Smyrk, City Commissioner. June 24.

Highlands, Col.—Pipe sewers, brick manholes, etc. John Valentine, Town Engineer. A. P. Smithers, Town Clerk. June 23.

Boston, Mass.—About 231 ft. of 18-in. pipe, 798 ft. earth excavation, 798 ft. of 24 × 36-in. brick sewer, 268 cu. yds. of brick masonry in American and 10 in Portland cement, 132 cu. yds. concrete, 800 ft. of 8-in. under drain. H. H. Carter, Superintendent of Streets. June 24.

Lawrence, Kan.—About 5,930 ft. of 8-in. pipe, 580 ft. of 12-in. A. G. Honnold, City Clerk. June 25.

Street Work.—***Chicago, Ill.***—For Jackson Boulevard filling, stone curbing, asphalt roadway, granolithic sidewalk, lamp posts, sodding, etc. West Chicago Park Commissioners. June 23.

Chattanooga, Tenn.—Granite block or brick paving on Market St. L. G. Walker, Chairman, Board of Public Works. July 1.

Washington, D. C.—Paving brick for Brightwood Ave. The District Commissioners. June 24.

Water Pipe.—***Chicago, Ill.***—About 100 pieces of 36-in cast-iron pipe. J. F. Aldrich, Commissioner of Public Works.

Road.—***Hayneville, Ala.***—Earth and timber road in Big Swamp; 16 ft. wide at top, 22 ft. at bottom, 4 ft. thick. W. M. Brightman. July 2

Dredging.—*Washington, D. C.*—In the Potomac River. Lieut.-Col. P. C. Hains, U. S. Engineer Office, June 25.

CONTRACTING.

Plate Girders.—*Washington, D. C.*—The following proposals for plate iron girders for the Congressional Library have been received by B. R. Green, Superintendent and Engineer: A. & P. Roberts & Co., Philadelphia, Pa., 3.1 cts. per lb.; Pennsylvania Steel Co., Steelton, Pa., 3.12 cts.; Keystone Bridge Co., Pittsburg, Pa., 3.14 cts.; Benner & Opdyke, Philadelphia, Pa., 3.14 cts.; New Jersey Steel & Iron Co., Trenton, N. J., 3.15 cts.; Phœnix Iron Co., Philadelphia, Pa., 3.15 cts.; Wallis Iron Works, Jersey City, N. J., 3.23 cts.; F. J. Myers Mfg. Co., Covington, Ky., 3.8 cts.; Pittsburg Bridge Co., Pittsburg, Pa., 3.33 cts. The contract was awarded to A. & P. Roberts & Co.

Street Work.—*Detroit, Mich.*—Contracts for cedar block paving on plank and sand have been awarded at $1.63¾ to $1.85¼ per sq. yd. The Talbot Paving Co. has a contract for Bucyrus brick paving on concrete, at $2.30¼ per sq. yd.

Levee.—*Robinsonville, Miss.*—A contract for 60,000 cu. yds. of levee work has been awarded to T. Sullivan, of Memphis, Tenn., at 19¾ cts. per cu. yd.

Sewers.—*Boston, Mass.*—Proposals have been received for Sections 2 and 12 of the metropolitan sewerage system. Mr. H. A. Carson is Chief Engineer. A, National Construction Co., Boston; B, Metropolitan Construction Co., Boston; C, R. A. Malone & Sons, Philadelphia, Pa.; D, O. P. Roberts, Cambridge; E. D. O'Connell, Dorchester.

No. 2.	Earth excav. and refill. 9 ft. diam. Outfall sewer. 500 lin. ft.	Rock excav. 50 cu. yds.	Brick mas., American. 400 cu. yds.	Brick mas., Portland. 1,200 cu. yds.	Concrete mas., Am. 200 cu. yds.	Concrete masonry, Portland. 1,500 cu. yds.	Rubble masonry, American. 500 cu. yds.	Spruce lumber in place. 10 M. ft. B.M.	Spruce piles, driven. 1,000 lin. ft.	Earth excav and refilling outside of trench 500 cu. yds.	Total.
	1,610 lin. ft.										
	$	$	$	$	$	$	$	$	$	$	$
A	18.00	9.17	5	12.00	13.50	4.95	6.25	5	10	30	15	1.25	59,003
B	16.35	8.15	5	12.17	14.59	3.99	6.55	8.45	35	13	1.50	60,000
C	18.00	9.00	3	13.00	14.50	5.50	6.00	6.25	30	20	1.00	60,365

No. 12.	100 × 108 ins. 3,050 lin. ft.	50 cu. yds.	1,450 cu. yds.	1,000 cu. yds.	1,800 cu. yds.	500 cu. yds.	800 cu. yds.	300 M. ft. B. M.	82,000 lin. ft.	500 cu. yds.	
D	11.20	2	13.36	14.41	5.00	6.35	5.50	25	17½	0.75	106,842
A	15.25	5	12.75	14.50	5.35	7.10	5.61	23	13	1.00	116,078
B	16.75	50	12.39	14.77	5.54	7.75	5.39	33	13	1.25	125,592
E	24.00	5	14.00	15.00	6.50	7.00	7.00	30	32	2.00	165,790

Sewers.—*Orange, N. J.*—Twelve proposals have been received for the new sewerage system, of which Mr. C. P. Bassett, of Newark, is the engineer. The bidders were as follows: 1, Sanford & Stillman, Jersey City, N. J.; 2, Chas. Jones, New York, N. Y.; 3, M. Sullivan, Little Falls, N. Y.; 4, Smith & Minahan, Easton, Pa.; 5, Empire Construction Co., New York, N. Y.; 6, R. A. Malone, Lancaster, Pa.; 7, J. McFarlane, Philadelphia, Pa.; 8, P. J. Condon, Jersey City, N. J.; 9, Joseph Moore, New York, N. Y.; 10, Denis Sullivan, Flushing, N. Y.; 11, James Sullivan, Philadelphia, Pa.; 12, W. E. Dean, New York, N. Y.

	Storm sewers. 3,500 ft. 84-in.	2,850 ft. 72-in.	1,710 ft. 66-in	880 ft. 54-in.	930 ft. 51-in.	550 ft. 42-in.	300 ft. 33-in.	Basin inlet conns. 6 ft. dp. 12-in. 500 ft.	10-in. 500 ft.	Pipe sewers and branches. 20-in. 3,040 ft.	Ys 120	18-in. 2,800 ft.	Ys 110	15-in. 5,300 ft.	Ys 210	12-in. 1,560 ft.	Ys 60	9-in. 2,540 ft.	Ys 100	8-in. 87,280 ft.	Ys 3,500	6-in ho conns. Telford 10,000 6 to 8 ft. dp.	5,000 8 to 10 ft. dp.	Dirt 7,000 6 to 8 ft. dp.	3,000 8 to 10 ft. dp.
	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	cts.	cts.	cts.	cts.
1	17.50	15.00	12.50	10.50	7.90	7.50	5.75	1.00	.80	2.25	3.00	2.15	2.00	1.75	1.20	1.30	1.00	1.00	.70	.75	.60	60	70	50	60
2	17.75	15.75	14.50	10.25	9.50	7.75	7.00	.65	.60	3.00	1.00	2.75	95	2.50	.90	2.25	.85	1.25	.80	.90	.70	50	50	50	50
3	17.00	14.50	13.00	11 50	11.0	10.00	7.90	.79	.73	3.00	2.64	3.00	1.51	1.73	1.52	.95	.85	.75	.50	.69	.40	45	50	33	39
4	14.41	11.01	10.01	7.01	6.51	6.01	4.51	1.41	1.21	3.01	2.81	3.21	2.11	2.41	1.91	1.51	1.81	1.21	1.71	.71	2.11	81	91	51	61
5	13.40	10.75	10.00	5.75	5.75	4.75	4.00	.75	.70	1.95	3.00	1.95	2.30	1.40	1.70	.95	1.09	.67	.67	.63	.60	40	48	35	38
6	19.00	16.00	15.00	12.00	9.00	8.00	7.00	1.25	1.15	5.00	30.00	4.75	30.00	4.00	3.00	3.00	15.00	2.50	15.00	1.75	1.20	100	110	100	110
7	14.25	13.75	11.75	9.25	7.00	6.00	5.50	.90	.85	2.07	1.66	1.79	1.15	1.44	.88	1.15	.60	.74	.44	.65	.38	45	45	45	45
8	16.00	14.00	12.00	8.50	8.00	6 50	6.00	1.25	1.15	4.95	1.00	4.95	1.00	3.00	1.00	2.00	1.00	1.50	1.00	1.10	.50	100	125	75	100
9	25.00	22.23	20.07	11.07	10.57	7.60	4.90	1.50	1.39	3.91	2.00	3.30	1 50	2.60	1.15	1.78	.80	1.10	.54	.96	.44	75	89	50	64
10	21.21	20.21	19.93	11.05	9.51	8.71	6.30	.95	.85	2.35	1.99	1.94	1.50	1 61	1.11	1.21	.76	.93	.50	.65	.41	45	53	35	43
11	22.00	16.00	15.50	13.00	12.00	10.00	6.58	1.50	1.50	7.00	3.00	7.00	3.00	5.50	2.50	3.50	2.00	1.75	1.50	1.50	1.00	100	100	100	100
12	13.60	12.90	10.85	8.21	8.00	6.25	6.20	.87	.77	2.44	2.00	2.16	2.00	1.93	2.00	1.63	2.00	.80	2.00	.80	2.00	68	70	45	60

	Manholes. 12 in. work, 300 ft. 8 in. work, 3,500 ft. Less than 12 ft.	More than 12 ft.	Basins, complete with head, 30.	Inlets, complete with head, 30.	Flush tanks complete, 30.	Lampholes, 200 ft.	Concrete, 1,000 cu. yds.	Rock excav. 500 cu. yds.	Iron castings, 160,000 lbs.	Iron pipe in place, vitrified.	Timber foundation, 25,000 ft. B. M.	Sheathing left in ditch, 160,000 ft. B. M.	Excavation below grade, 1,000 yds.	Tile. of 2½ in.	of 3-in.	of 4-in.	of 6 in.	of 8-in.	of 10-in.	of 12-in.	Totals.
	3,500 ft.	300 ft.												5,000 ft.	5,000 ft.	5,000 ft.	5,000 ft.	5,000 ft.	2,000 ft.	3,000 ft.	
	$	$	$	$	$	$	$	$	Cts.	$	$	$	$	Cts.	Cts.	Cts.	Cts.	Cts.	Cts	Cts.	$
1	2.00	3.00	100	40	50	1.50	7.00	2.50	4	15	30.00	25.00	1.00	25	26	28	30	33	38	40	307,044
2	2.90	4.00	125	35	100	2.60	5.00	3.00	3½	110	25.00	15.00	1.00	10	12	15	17	21	25	35	334,550
3	4.00	5.50	150	75	45	.30	4 50	4.90	2½	45	16.00	16.00	1.00	22	23	24	27	30	38	41	307,744
4	3.41	4.51	101	91	61	1.71	6.11	1.51	3¼	31	34.91	28.11	1.11	11	11	14½	16½	23½	31	41	291,653
5	2.20	4.00	70	45	45	1.00	4.75	2.25	2¾	30	30.00	23.00	.90	15	15	15	20	20	30	40	239,174
6	3.00	4.00	4,500	1,800	3,000	2.00	6.00	2.00	4	35	25.00	25.00	1.50	25	25	30	50	60	75	90	464,392
7	2.10	2.35	40	80	60	1.00	3.00	3.00	2½	33	16.00	19.00	1.50	5	15	20	25	25	30	35	259,769
8	3.50	4.00	100	50	60	1.00	5.00	3.00	4	30	30.00	30.00	2.00	25	30	30	50	75	100	100	372,852
9	3 10	6.25	125	100	54	2.60	8 00	4.00	2½	24	25.00	22.00	2.00	1	1	1	1	25	33	43	407,274
10	3.39	3.77	115	80	87	33.92	1.99	5.50	2.50	3½	32	28.00	21.50	.95	27	31	37	49	57	66	73	345,502
11	4.00	4.00	110	90	150		2.00	6.00	1.00	5	40	40.00	25.00	1.00	50	60	70	80	90	125	150	499,650
12	2.45	3.25	135	50	135		2.45	4.00	2.00	6	30	30.00	25.00	1.00	33	33	35	37	43	45	52	300,528

Sewers.—*Denver, Col.*—The following proposals have been received for the construction of the Delgany St. brick sewer, and the contract has been awarded to Murphy & Nelles, of Denver, Col., and Omaha, Neb. The 100-ft. oval section, 42 × 63 ins., is in rubble masonry at Cherry Creek crossing.

	Circular in rubble masonry. 310 ft. of 92-in.	1,047 ft. of 91 in.	300 ft. of 91-in.	3-ring circular. 392 ft. of 91-in.	1,192 ft. of 90-in.	320 ft. of 78 in.	1,136 ft. of 72-in.	530 ft. of 58-in.	Oval. 1,143 ft. 42×63 ins	1,473 ft. 30×45 ins	2,344 ft. 28×42 ins	100 ft. 42 × 63-in.	2,000 ft. 32 × 48 in. wooden box.	Total.
	$	$	$	$	$	$	$	$	$	$	$	$	$	$
Murphy & Nelles	22 80	24.64	28.88	13.40	13.62	14.18	12.65	9.96	8.90	7.81	6.49	61.35	0.97	145,683
Wickham & McIntire	27.31	30.08	33.16	18.50	19 52	17.00	14.26	11.46	10.27	6.00	6.00	70.00	1.25	166,120
J. B. Hendrie	26.50	17.10	17.10	17.10	17.10	14.94	14.90	12.90	12.25	12.25	10 50	40.75	1.46	161,291
J. E. Riley & Co	23.00	27.50	29.00	16 55	16.50	15.00	14.50	12.00	12.00	8.50	8.50	56.00	1.00	163,589
J Williams	27 00	27.00	17.00	16 50	17.00	15.50	15.00	10.00	12.00	5.70	6 00	59.00	0.75	151,179
Sullivan & Steinmetz	30.00	30.00	33.00	16.50	16.50	14.25	14.00	11.25	11.0	7.50	7.35	60.00	2 50	167,625
J. P. O'Neil & Co	27.62	29.50	29.75	18.56	18.37	17.60	15.15	13.15	9.76	7.50	7.50	70.00	1.30	169,063

Sewers.—*Lynn, Mass.*—The following proposals for the construction of section No. 2 of the western intercepting sewer were received June 11 by Mr. C. W. Gay, City Engineer. The bidders were as follows: A, National Construction Co., Boston; B, John Sheehan, Lynn; C, James Heath, Lynn:

		A.	B.	C.
8,250	cu. yds. earth excav. and refill in trench	$ .85	.80	.90
75	" " earth excav. and refill	.85	.40	.60
25	" " rock excav	5.00	3.00	5.00
150	" " concrete	5.00	6.00	8.00
1,600	" " brick mas.; Am. cem. mortar	12.35	13.00	12 00
15	" " brick mas.; Portl. cem. mortar	13.85	14.00	15.00
10	" " rubble stone masonry	6.25	4.00	6.00
24	sq. yds flag stone masonry	1.50	.50	.80
4,400	lin. ft. 8-in. drain pipe in place	.35	.35	.50
16	catch basins, complete	65.00	75.00	65.00
200	lin. ft. 10-in. catch basin, conn. pipe in place	1.00	.60	.70
350	8-in. slants in place	.75	.35	.50
20	M. ft. B. M. spruce lumber, in place and secured	33.00	30.00	45.00
	Total	31,350	51,799	32,364

Omaha, Neb.—The contract for 1,670 feet of 32-in. brick culvert has been awarded by the Board of Public Works to Reeves & Co., at $7.75 and $6.10 per lin. ft. for 3 and 2-ring culvert, and 75 cts. each for catch basins.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Rogers Locomotive & Machine Works, of Paterson, N. J., are building decapod engines, weighing 150,000 lbs., for the Chicago, Burlington & Quincy; cylinders, 22 × 28 ins.; driving wheels, 50 ins.; boiler, 58 ins. The Brooks Locomotive Works, of Dunkirk, N. Y., have built 2 passenger and 5 freight engines for the Cleveland & Canton.

Cars.—The Harvey Steel Car Co. has an order from the Chicago, Milwaukee & St. Paul for 15 stock cars, 36 ft. long, of 60,000 lbs. capacity. The Barney & Smith Mfg. Co., of Dayton, O., has built 5 dining cars and 45 passenger cars for the Northern Pacific. The McKee & Fuller Car Co., Pa., has an order for 1,000 freight cars for the Lehigh Valley. The Ohio Falls Car Co., of Jeffersonville, Ind., has an order for 500 freight cars for the Pennsylvania. The Southern & Pacific Refrigerator Car Co., of Chicago, Ill., is building 10 cars on the Riordan plan.

Freight Stations.—A Chicago syndicate is said to contemplate the construction of an extensive freight station and warehouses.

Boilers.—Riter & Conley, of Pittsburg, Pa., are building seven boilers for the steel works of the Pittsburg Iron & Steel Engineering Co., at West Superior, Wis. Each boiler is 10 ft. diameter and 30 ft. long, 236 tubes 4 ins. diameter and 20 ft. long. The working pressure is 150 lbs. Weight, 40 tons.

Pipe.—The contract for pipe for the new gas plant of the Citizens' Gas Co., Shelbyville, Ind., has been awarded to the Wheeling Iron & Steel Co. for $60,000. There will be 14 miles from Fountaintown to the city, and 15 miles within the corporate limits.

The Thomson-Houston Electric Co. reports the sales of 2,238 arc lights to 38 towns; 34,400 incandescent lights to 33 towns; 3 isolated arc plants of 195 lights, and 19 isolated plants of 6,550 incandescent lights.

Companies.—Canda Mfg. Co., of Carteret, N. J.; railway equipment; C. J. Canda and J. W. Savin, of New York; capital stock, $1,000,000. Royal Bridge & Iron Co., of Montreal, Que.; $20,000. Murray Metallic Packing Co., of Albany, N. Y.; E. J. Murray, T. J. Sullivan, E. A. Maher; $25,000 Metropolitan Steam Power Increasing & Fuel Saving Co., of Newark, N. J.; J. J. Bush and Geo. H. Bush; $100,000. Empire Construction Co., of New York; to build railways, roads, canals, sewers, etc.; B. D. Greene, A. M. Newton, John Roebuck; $50,000. Corrugated Steel Wheel Co., of Chicago, Ill.; W. E. Williams, Geo. B. Lathrop and S. F. Edwards; $100,000. Duplex Street Railway Track Co., of Wheeling, W. Va.; H. A. Kirkham, W. B. Rankine and Eustace Conway, of New York, N. Y.; $1,500,000.

Metal Market Prices.—*Rails.*—New York; $30.75 to $31; old rails, $20 50 for iron and $17 for steel. Pittsburgh: $30; old rails, $22.50 to $23 for iron and $17 to $18 for steel. Chicago: $31; old rails, $22.75 for iron and $14.50 to $17 for steel.

Track Materials.—New York: steel angle bars, 1.7 to 1 75 cts.; spikes, 1.9 to 1.95 cts.; track bolts, 2.60 to 2.65 cts. with square, and 2.75 cts. with hexagon nuts. Pittsburg; splice bars, 1.8 to 1.9 cts. for iron or steel; iron or steel spikes, 2.05 cts.; iron track bolts, 2.75 cts. with square and 2.85 cts. with hexagon nuts. Chicago: splice bars, 1.85 to 1.9 cts. for iron, 2 to 2.05 for steel; spikes, 2 to 2 1 cts.; track bolts, 2.8 to 2.9 cts. with hexagon nuts.

Foundry Pig Iron.—New York: $14 to $18. Pittsburg: $14.50 to $17. Chicago: $14.50 to $18.

Pipe.—Cast iron, $25 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 55 and 45 per cent. on black and galvanized butt-welded; 65 and 52½ on black and galvanized lap-welded. Casing, 55 per cent.

Lead.—New York: 4.4 to 4.45 cts. Chicago: 4.3 to 4.4 cts St. Louis: 4.15 cts.

Structural Material.—New York: beams, 3.1 cts. channels, 3.1 cts.; angles, 1.95 to 2.1 cts.; tees, 2.45 to 2 75 cts.; sheared iron plates, 1.95 to 2.25 cts.; steel plates, 2 to 2.15 cts. for tank, 2.3 to 2.6 cts. for shell, 2.5 to 2.7 cts. for flange, 3.75 to 4.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2 cts.; tees, 2.6 cts.; universal iron mill plates, 2.05 cts.; sheared steel bridge plates, 2.1 to 2.15 cts.; refined bars, 1.8 to 1.9 cts.; steel plates, 2.1 cts. for tank, 2.45 cts. for shell, 2.7 cts. for flange, 3.9 to 4.25 cts. for firebox. Chicago: beams, 3.2 cts. channels, 3.2 cts.; angles, 2.25 to 2.3 cts.; tees, 2.6 to 2.7 cts. universal plates, 2.3 to 2.4 cts.; sheared plates, 2.5 to 2.6 cts. for iron and 2.6 to 2.7 cts. for steel; steel plates, 2 6 to 2.7 cts. for tank, 3.25 cts. for shell, 3.5 cts. for flange 4.25 to 5.5 cts. for firebox; boiler rivets, 4 to 4.25 cts.

Niles, O., Water-Works.

Notice to Contractors.

SEALED PROPOSALS WILL BE RECEIVED by the Village Council of Niles, Trumbull County, Ohio, UNTIL NOON, JUNE 30TH, 1891, for furnishing material and constructing water-works for said village as follows:

One infiltration or supply basin, one building and one chimney, one storage reservoir, two pumping engines of 1,000,000 gallons each in 24 hours. Bids will be received for compound condensing and compound non-condensing machinery. Also two boilers for said works, including engine foundations, boiler setting, together with all pipes and fixtures complete.

Also the furnishing of 600 ft. of 14-in., 120 ft. of 12-in., 2 400 ft. of 10-in., 16,500 ft. of 8-in., 14,900 ft. of 6-in. and 12 750 ft. of 4-in. cast-iron coated water pipe, aggregating about 810 tons of 2,000 pounds. Also about 22 tons of special castings; also the laying of pipe and specials. Also the furnishing of 80 fire hydrants, 56 stop valves and 56 valve boxes, and setting same.

Bids will be received for the Water-Works System complete, or for any department of work, or material separately. The Council reserves the right to reject any or all bids. Plans and detailed drawings can be seen at the office of the Village Council on and after June 10. Specifications furnished contractors by the consulting engineer or the village clerk. Proposals must be indorsed "Water-Works Proposal."

J. B. STRAWN, Consulting Engineer,
273 Lincoln Ave., Salem, O.
M. J. FLAHERTY, Village Clerk,
Niles, O.

NILES, O., May 26, 1891. 22-5t

Sealed Proposals will be received at this office until July 6th, 1891, at 12 M., for the building of a sewerage system for the city of Vicksburg, Miss., as per plans and specifications now on file in the office of the City Clerk. The Board of Mayor and Aldermen reserve the right to reject any and all bids.

R. V. BOOTH, Mayor.

VICKSBURG, Miss., May 25th, 1891. 22-5t

New Pumping Engines for Atlanta, Ga.

Sealed proposals will be received at the water-works office in the city of Atlanta, Ga., until 12 o'clock meridian, on the 8th day of July, 1891, for furnishing three horizontal high-duty compound pumping engines. Two of said engines to be located close to the Chattahoochee River, near the mouth of Peachtree Creek, and distant from the center of the city about seven miles. Each of these two engines to have the capacity to deliver 10,000,000 galls. in 24 hours against a pressure of 105 lbs. per sq. in. into a receiving reservoir. The other one engine to be located at a point between the river and city, and between three and four miles distant from the center of the city. This engine will be required to pump directly into the city water mains against a varying pressure of from 105 to 160 lbs. per sq. in., and to be so constructed that the pressure may be increased from the first to the second figure within two minutes from the time of receiving a fire alarm at the station.

Bids should be sealed and addressed to the Hon. Board of Water Commissioners, Atlanta, Ga.

Specifications may be had by addressing R. M. Clayton, City Engineer, or Wm. G. Richards, Superintendent, Atlanta, Ga.

The right is reserved to reject any or all bids.

HOWELL C. ERWIN, President.

ATLANTA, Ga., June 5, 1891. 24-4t

Notice to Bridge Builders.

Sealed proposals, marked "Proposals for St. Martin Bridge," will be received by the County Commissioners of Stearns County, Minnesota, at the Office of the County Auditor, St. Cloud, Minn., up to Monday, July 13, 1891, at 3 o'clock P. M., for building and erecting complete an iron highway bridge of one hundred and sixty (160) feet span, across Sauk River, in the town of St. Martin.

Plans can be seen and specifications obtained from the County Auditor or Engineer. Bids will be received for substruction and superstruction separately or both together. A certified check for two hundred ($200) dollars, payable to the order of the County Treasurer, must accompany each bid as a guarantee that, if awarded the work, a satisfactory bond for one-fifth the amount of the bid will be given and contract entered into within five days from date of award. The right is reserved to accept that bid which is for the best interest of the county whether the lowest or not, and to reject all bids if desired.

PAGE & SMITH,
Engineers, St. Cloud, Minn.

Dated at St. Cloud this 6th day of June, 1891.

BARTH. PIRZ,
EDWARD MILLER,
JOSEPH SCHEELAR,
Committee.

24-3t

UTICA PIPE FOUNDRY CO.

CAST IRON PIPE AND SPECIALS FOR WATER AND GAS.
Also Flanged Pipe and Fittings, Hydrants, Gates, Pig Lead, etc.
CHAS. MILLAR & SON, Selling Agts., Utica, N. Y
Manufacturers of Lead Pipe and Plumbers' Materials.
Wholesale Eastern Agents Akron Vitrified Sewer Pipe.

MONTAGUE & CO.,
MANUFACTURERS
FIRE BRICK, SEWER PIPE,
DOUBLE STRENGTH
RAILROAD CULVERT PIPE,
With long sockets, in two and one-half foot lengths.
CHATTANOOGA, - - - TENN.

Notice to Contractors.

LACONIA, N. H.—SEWERAGE.

Sealed proposals will be received until noon of Tuesday, June 23, 1891, by the Sewer Committee of Laconia, N. H., for the construction of sewers and subsoil drains in the village of Laconia, consisting, approximately, of

4,410	lineal ft. of	twelve (12)-in. vitrified	sewer.
4,790	"	ten (10)-in.	" "
8,110	"	eight (8)-in.	" "
39,127	"	six (6)-in.	" "
460	"	ten (10)-in. cast-iron	pipe.
300	"	twelve (12)-in.	" "

52 flush tanks.
1 large tank.
20 manholes.
150 inspection or lampholes. Together with the necessary bends, branch connections, stoppers, etc.

Proposals must be made on blank forms furnished by the Committee, and all legal formalities must be complied with to secure consideration of proposals.

Plans, profiles and details for the above work can be examined and specifications and blank forms obtained at the office of the Town Clerk, Laconia, N. H., or of the Engineers, Waring, Chapman & Farquhar, Newport, R. I.

Proposals must be sealed and addressed to the Committee, and be indorsed "Proposals for Sewers," and with the name of the person, firm or corporation which makes the tender, and be accompanied by a certified check for $1,000, payable to the order of the Town Treasurer.

The Committee reserve the right to reject any or all proposals.

SAMUEL B. SMITH,
ALMON J. FARRER,
FOREST G. BERRY,
ALBURTUS S. GORDON,
NAT. J. EDGERLY,
Sewer Committee.

WARING, CHAPMAN & FARQUHAR,
Engineers, Newport, R. I. 24-2t

Constructing Water Tunnel Under the River at Thirty-Fifth Street.

OFFICE OF THE DEPARTMENT OF PUBLIC WORKS, CHICAGO, June 12, 1891.

Sealed proposals will be received by the city of Chicago until 11 A. M., Friday, June 26, 1891, for the construction of a water-pipe tunnel, including two shafts, under the south fork of the Chicago River at Thirty-fifth street.

According to plans and specifications on file in the office of the department of public works of said city.

Proposals must be made out upon blanks furnished at said office, and be addressed to said department indorsed, "Proposal for Water-Pipe Tunnel at Thirty-fifth Street," and be accompanied with $500 in money or a certified check for the same amount on some responsible bank doing business in the city of Chicago and made payable to the order of the commissioner of public works.

The commissioner of public works reserves the right to reject any or all bids.

No proposal will be considered unless the party offering it shall furnish evidence satisfactory to the commissioner of public works of his ability, and that he has the necessary facilities, together with sufficient pecuniary resources, to fulfill the conditions of the contract and specifications, provided such contract should be awarded to him.

Companies or firms bidding will give the individual names as well as the name of the firm with their address. J. FRANK ALDRICH,

25-1t Commissioner of Public Works.

Port Clinton Short Line Railway.

SEALED PROPOSALS WILL BE RECEIVED at this company's office, in Port Clinton, Ottawa Co., O., until 11 A. M. on Monday, June 22, 1891, for supplying all rails, fastenings and ties for and laying 12 miles of standard track from Short Line Junction to Port Clinton. The work is to be completed within 90 days from June 22, 1891, and payment for all of same to be made in the company's first mortgage bonds at 90 cents on the dollar. All rights of way now secured, and grading, bridging and culverts done ready for track-laying.

The first mortgage will cover the entire 12 miles of property and valuable terminals, and the whole issue of bonds secured by same will be fixed at $100,000, bearing 6% interest.

Specifications and form of bid on application.

Right reserved to reject any and all proposals

EDGAR H. BRENNAN,
President and Engineer.

PORT CLINTON, Ottawa Co., O.,
May 13, 1891. 21-5t

Proposals.

OFFICE WATER-WORKS, SAVANNAH, GA., May 21, 1891.

SEALED proposals will be received by the City of Savannah, Georgia, until eleven (11) o'clock A. M., July 15th, 1891, for furnishing and constructing Two (2) High Duty Pumping Engines, each having a capacity of Ten Million (10,000,000) U. S. gallons per day, and the necessary Boilers and other appurtenances pertaining to a pumping plant. All to be in accordance with general specifications on file in the Water Office at Savannah, Ga., or which, with all other information, can be obtained from Thomas T. Johnston, Consulting Engineer, at room No. 29, No. 171 La Salle street, Chicago, Illinois.

Proposals must be made in accordance with the aforesaid general specifications. No proposal will be considered unless the party offering it can furnish evidence satisfactory to the Mayor and Board of Aldermen of the City of Savannah of his ability, and that he has the necessary facilities, together with sufficient pecuniary resources, to fulfill the conditions of the contract and the specifications, provided such contract should be awarded him.

The right to reject any and all proposals not deemed for the best interest of the city is reserved. JAMES MANNING,

22-4t Superintendent.

Notice to Sewer Contractors.

CITY OF SPRINGFIELD, June 13, 1891, WATER COMMISSIONERS' BLOCK, SPRINGFIELD, Mass.

SEALED PROPOSALS indorsed "Proposal for Sewers" will be received by the undersigned until Tuesday, 12 o'clock M., June 30, 1891, for the construction of brick sewers in the city of Springfield, of the following length and interior dimensions:

Length.	Size.
445 ft.	3 ft. 10 ins. × 5 ft. 9 ins.
1,050 "	3 " 4 " × 5 " 0 "
605 "	3 " 2 " × 4 " 9 "
880 "	2 " 4 " × 3 " 6 "
3,000 "	2 " 0 " × 3 " 0 "
360 "	1 " 10 " × 2 " 9 "
360 "	1 " 8 " × 2 " 6 "
360 "	1 " 6 " × 2 " 3 "

Plans and specifications may be seen, blank forms for bids and other information obtained at the City Engineer's Office in said Springfield. All bids must be accompanied by a certified check for $500, and a bond for not less than one-third of the total bid will be required of the successful bidder. Bidders will also be required to furnish satisfactory evidence of their business standing as well as their experience and ability to successfully perform the work under consideration.

The right is reserved to reject any or all bids.

WILLIAM L. DICKINSON, Supt. of Sewers.

Per order of the Committee on Sewers and Drains. 25-2t

Cambridge, O., Water-Works.

Sealed proposals will be received by the Village Clerk of the Village of Cambridge, Guernsey Co., O., until 7½ o'clock P. M., July 15, 1891, for a first-class system of water-works, said works to be operated on the rental plan.

The works shall be a combination of the direct pumping and stand-pipe system, so called, and capable of being operated by either.

The capacity of said works not to be less than 2,000,000 U. S. gallons per day.

For further particulars as to specifications etc., inquire of Village Clerk.

The Village Council reserves the right to reject any or all bids.

JNO. S. BLACK,
Village Clerk.

O. M. HOGE,
City Engineer.

CAMBRIDGE, O., June 6, 1891. 24-2t

To Dredging Contractors.

Bids wanted to put 45,000 yards earth filling behind seawall at Governor's Island. Reply by letter to 2 Palisade Ave., Yonkers, or apply in person on the Island.

25-1t BREUCHAUD, PENNELL & CO.

Notice to Sewer Contractors.

WILMINGTON, DELAWARE.

SEALED PROPOSALS for the construction of approximately 6,400 feet of stone and brick sewers and 1,800 feet of pipe sewers and appurtenances will be received at the office of "The Board of Directors of the Street and Sewer Department" up to 7:30 o'clock p. m., June 30, 1891. Plans can be seen at the office of the engineer in charge of sewers, and forms of proposal, contract and specifications will be sent to those desiring them. All bids must be made upon the blank form furnished by the engineer. A certified check for $500 will be required to accompany each proposal and a bond for not less than one-third of his total bid will be required of the successful bidder. The Board reserves the right to increase or diminish the quantities bid for or to reject any or all bids. The internal diameters of the sewers run from 2 feet 9 inches to 9 feet, and some other particulars are approximately as follows:

Length.	Cu. yds. excavation.	Cu. yds. brick masonry.	Cu. yds. stone masonry.
3,326 feet	4,956	875	
1,935 "	2,930	466	
336 "	266	190	565
196 "	520	85	435
540 "	2,700	200	1,970
1,729 "	1,569	18" to 8" pipe.	

T. CHALKLEY HATTON,
Engineer in Charge of Sewers.

Dated June 10, 1891. 24 3t

Furnishing and Laying Water Pipe and Appurtenances for the Columbian Exposition, Chicago Ill.

Sealed proposals will be received by the Chief of Construction, World's Columbian Exposition, until one o'clock P. M., Tuesday, June 30, 1891, for furnishing and laying water pipes and appurtenances in Jackson Park, according to plans and specifications on file in the office of the Chief Engineer, 1143 "The Rookery," Chicago, Ill. Approximate amount as follows: 758 lin. ft. of 6-in. cast-iron pipe; 1,281 lin. ft. of 8-in. cast-iron pipe; 2,518 lin. ft. of 12-in. cast-iron pipe; 235 lin. ft. of 16-in. cast-iron pipe; 6,600 lin. ft. of 24-in. cast-iron pipe; 4,575 lin. ft. of 30-in. cast-iron pipe; 48 lin. ft. of 36 in. cast-iron pipe; 38 hydrants, 52 stop gates. Proposals must be made on blanks and inclosed in envelopes furnished by the Construction Department, and addressed to D. H. Burnham, Chief of Construction, at the same place. Bids must be indorsed on the outside, "Proposal for Furnishing and Laying Water Pipe," and must be accompanied with a certified check for six thousand dollars ($6,000) on some bank doing business in Chicago, and made payable to the World's Columbian Exposition. The Chief of Construction reserves the right to reject any or all bids. D. H. BURNHAM, Chief of Construction, World's Columbian Exposition, 1143 "The Rookery," Chicago, Ill.

CHICAGO, June 17, 1891. 25-1t

U. S. ENGINEER OFFICE, ARMY BUILDING, New York, May 23, 1891. Sealed proposals, in triplicate, will be received at this office until 12 o'clock noon, June 24, 1891, for the construction and delivery of one iron roof truss for torpedo shed at Sandy Hook, N. J. The attention of bidders is invited to acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, vol. 23, page 332, and vol. 24, page 414, Statutes-at-Large. For specifications, blank forms, and all information, apply to the undersigned, G. L. GILLESPIE, Lieut.-Col. of Engineers. 13-3t

[For other Proposals see following page.

PROPOSALS FOR DREDGING.—U. S. Engineer Office, Montgomery, Ala., June 10, 1891. Sealed proposals in triplicate, for dredging in Apalachicola Bay, Florida, will be received at this office until 12 o'clock noon standard time, on July 15, 1891, and will be then opened. The attention of bidders is invited to the Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large. Specifications, instructions for bidders and blank forms for Proposals may be obtained at this office. PHILIP M. PRICE, Captain Corps of Engineers. 25-4t

PROPOSALS FOR DREDGING.—U. S. Engineer Office, 601 Eighteenth St. N. W., Washington, D. C., June 6, 1891. Sealed proposals, in triplicate, for dredging in the Potomac River at Washington, D. C., will be received at this office until 12 M. on Thursday, June 25, 1891. The attention of bidders is invited to the Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large. For specifications, forms of bids and other information apply at this office. PETER C. HAINS, Lieut.-Colonel of Engineers. 25-1t

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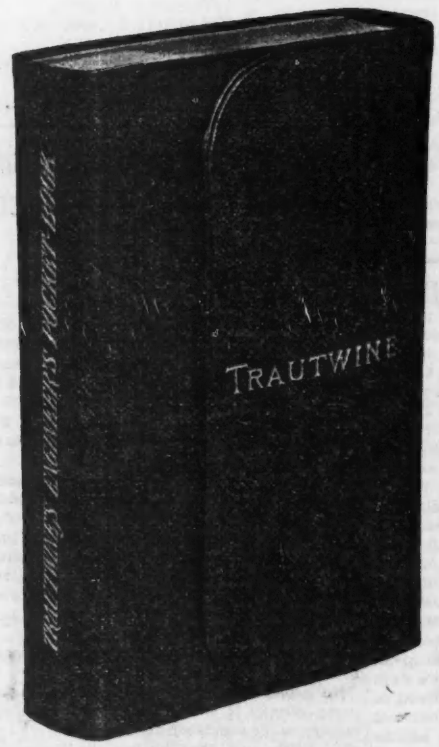

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